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Concreting Plant for Large Chicago Warehouse

The new building of the Midland Warehouse & Transfer Co., at Western Ave. and 15th St., Chicago, is of reinforced-concrete construction, except for a three-track steel trestle which enters at a level 4 ft. below the second floor and forms a connection with the Chicago Junction Ry.

The building is approximately 405x260 ft. in plan, with four stories and basement, the stories being 11 to 14 ft. high. Typical floor bays are 18 ft. 6 in. by 18 ft. 8 in., of girderless floor construction on the Leonard four-way reinforcement system, supported on round columns which are reinforced both spirally and with vertical bars. The slab thickness ranges from 7½ to 13 in., according to the floor loads, which are as follows: 400 lb. per sq.ft. for the first floor, 350 lb. for the second (with tracks), 300 lb. for the third and 250 lb. for the fourth.

The building and its permanent steel trestle are supported on spread footings, the unit soil loading being such that adjacent trestle footings come within a few inches of one another. The large ground area of the building, and the impossibility of occupying any considerable portion of the streets which bound three sides of the building, or the railway right-of-way which bounds the fourth side, dictated the design of a concrete-handling plant based on the use of the steel trestle. This trestle was erected as early as possible to constitute a part of the construction plant used for all work except the footings of the building.

The general layout of the plant is shown in Fig. 2. Sand, gravel and stone are discharged from bottom-dump cars into storage piles below the trestle, and on top of a tunnel with A-shaped sloping roof; the sand and stone or gravel are separated by a plank bulkhead at the peak of the tunnel roof. Holes in the side of the tunnel, controlled by gates, admit stone and gravel into measuring hoppers at four points. The measuring hoppers have sloping bottoms and on the release of a swinging gate the measured charge is dumped into a Ransome 1-yd. skip car running on light rails. On a signal from a man in the tunnel the skip is pulled up an incline and automatically dumped into a ¾-yd. Marsh-Capron motor-driven mixer, which discharges the mixed batch of concrete into a 1-yd. Lakewood elevator bucket. The chute hoppers are then located at such elevations on the tower as to permit the chuting of the concrete to any place on the floor.

FIG. 1. CONSTRUCTION OF THE NEW BUILDING FOR THE MIDLAND WAREHOUSE & TRANSFER CO., AT CHICAGO
This view shows work on the second floor of the four-story structure. Supply cars are run in on the permanent three-track steel trestle which extends into the building. The storage piles are beneath this, and a cable-operated skip serves the two mixers in the elevator towers

Both the skip car and the concrete elevator bucket are handled by a 52-hp. motor-driven double-drum Thomas hoist. A mixer is located at each end of the tunnel directly in line with the track for skip cars. This track is continuous from mixer to mixer and is laid level under the storage piles for a short distance midway between the two mixers. This permits the skip car from either mixer to run down its incline by gravity and stop in the tunnel under any one of the four measuring hoppers. These hoppers are 12 ft. apart, and when the storage above one hopper has been drawn down so low that it will not flow freely into that hopper, the skip is loaded from the next hopper while the exhausted storage is renewed from the next carload of material on the trestle above.

About 450 yd. of stone or gravel and 350 yd. of sand are available in live storage—that is to say, storage that will run freely into the measuring hoppers. Below this is sand and stone in dead storage which can be fed to the measuring hoppers by hand shovels. This dead storage pile serves the double purpose of eliminating the cost of a timber structure sufficient for the purpose of live storage, and also affords an emergency supply in case of delay in delivery of materials. The live storage would ordinarily be considered insufficient, but this has been entirely offset by the exceptionally good car service due to the railway connections. It has been found possible so to arrange the arrival of stock that no shoveling has been necessary. The only labor required to deliver stone and sand to each mixer comprises two men inside the tunnel admitting sand and stone to the measuring hoppers and then into the skip car, and half the time of the engineman who operates both the skip and the concrete bucket.

Cement is unloaded directly from the car to the mixer platform by the use of a chute as shown in Fig 4. A reserve stock is carried in cement storage sheds under the trestle in the location shown in Fig. 2.

The method of handling the concrete after it leaves the elevator bucket is determined by conditions which will undergo change after the building reaches the third-floor level. The towers are located between the two tracks of the trestle; and as cars are continuously passing on the trestle, chutes are used to carry the concrete above the cars from the towers to hoppers located as required on each floor. For the third and fourth floors and the roof the chutes will be discontinued, as these slabs extend continuously over the trestle area. Figs. 1 and 3 show the plant and the work in progress.

The plant was designed to meet a schedule calling for the placing of all superstructure concrete between Mar. 18 and June 4. This was on the basis of 11 weeks for 17,300 cu.yd. of concrete, or an average of 1570 cu.yd. of concrete per week. On Apr. 15 a general strike of Chicago carpenters partly stopped work on the job, which at that time was one week ahead of the above schedule. General labor troubles came about May 1, completely stopping the job. The first- and second-floor slabs had been poured

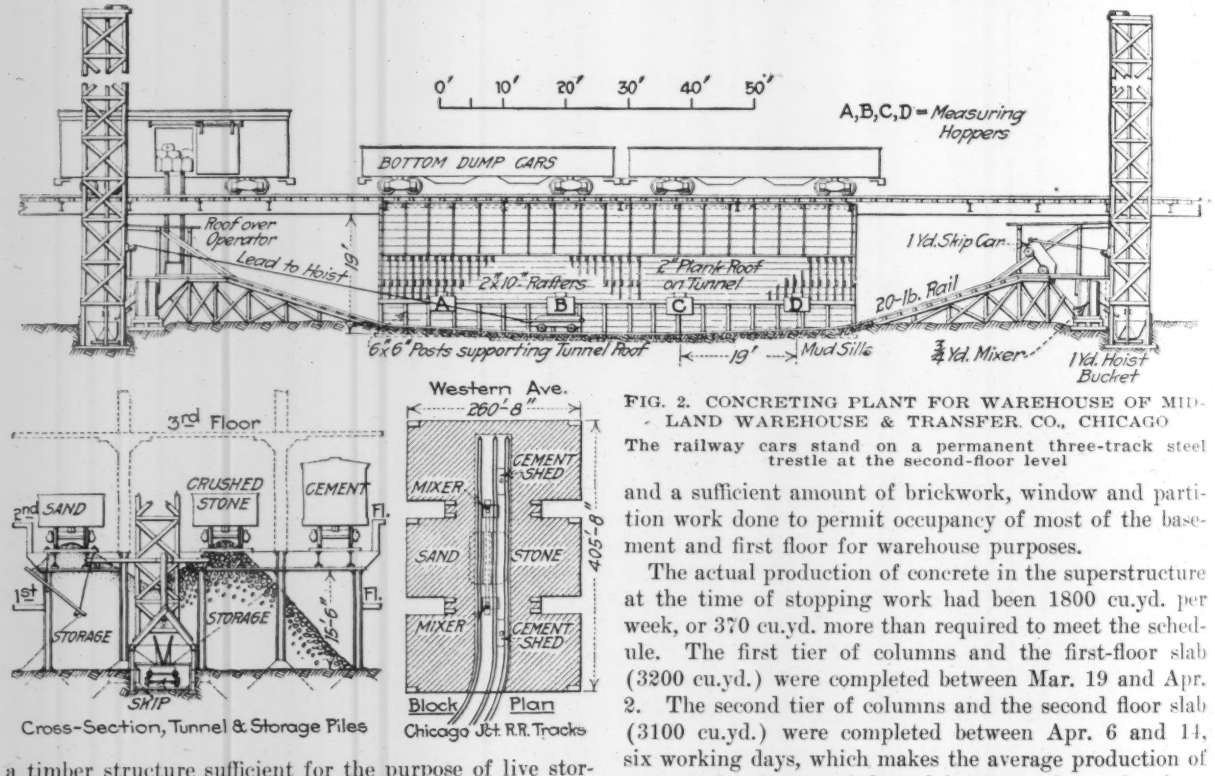


FIG. 2. CONCRETING PLANT FOR WAREHOUSE OF MIDLAND WAREHOUSE & TRANSFER CO., CHICAGO

The railway cars stand on a permanent three-track steel trestle at the second-floor level

and a sufficient amount of brickwork, window and partition work done to permit occupancy of most of the basement and first floor for warehouse purposes.

The actual production of concrete in the superstructure at the time of stopping work had been 1800 cu.yd. per week, or 370 cu.yd. more than required to meet the schedule. The first tier of columns and the first-floor slab (3200 cu.yd.) were completed between Mar. 19 and Apr. 2. The second tier of columns and the second floor slab (3100 cu.yd.) were completed between Apr. 6 and 14, six working days, which makes the average production of concrete for the second-floor slab 450 cu.yd. per day from two ¾-yd. mixers. The largest single day's run from the two mixers was 550 cu.yd. and the largest day's run from one machine was 308 cu.yd. These were all 8-hr. days.

The labor required for each mixer to deliver concrete into the hoist bucket ready for hoisting is as follows: Two men at the measuring hoppers in the tunnel, 1 man unloading cement from car to mixer platform, 1 man placing cement in mixer, 1 man operating mixer; half of hoisting engineman's time operating skip car; occasional services of train crew dumping stock off cars into storage. This force actually turned out concrete at the rate of 60 batches per hour for periods of several hours' duration.

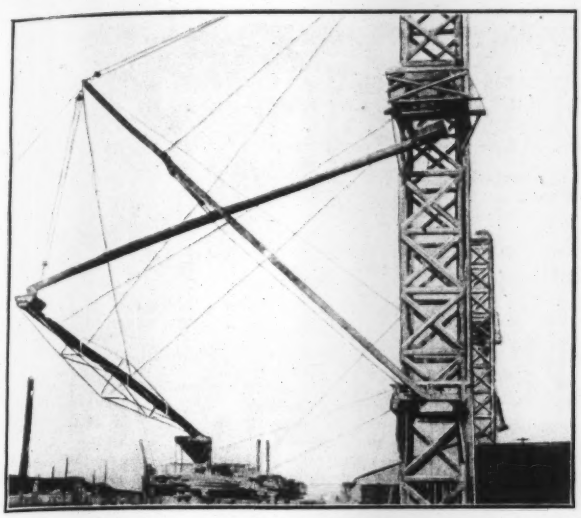


FIG. 3. METHOD OF SUPPORTING THE CONCRETING CHUTES FROM THE ELEVATOR TOWER

The reinforcing steel was furnished by the Concrete Steel Products Co. in connection with plans for the Leonard system of flat-slab construction. The steel received on the job was already fabricated as far as possible; that is, heavy bars were bent ready for placing, and the column spirals were delivered made up but collapsed to reduce bulk in shipment. Therefore no elaborate bending plant was necessary, and as a very small range of bar sizes was employed, no great storage space was needed. The bars for the four-way slabs were placed in long lengths, wired together at the intersections over the column heads. The network of wires at the column heads was sufficiently open to offer no particular obstruction to the placing and tamping of concrete.

The methods used in form construction follow closely the accepted practice for flat-slab jobs. Metal column forms of the Johnson system are erected inside of a four-post framework which supports the rectangular column head, which in turn carries the flared top section of the metal column form. The supporting framework for flat-slab forms is carried by the four-post structures around the columns. The center of each panel is supported by shores rendered adjustable by the usual double wedges.

Special construction will be necessary to carry the third floor over the 72-ft. space occupied by the trestle. Two lines of columns divide this space into 24-ft. spans, but the necessity of maintaining car operation on the trestle while this floor is being constructed makes it impossible to use any shores between columns, and the falsework around the columns must be kept within the limits of car clearances.

A small carpenter shop fitted with cutoff saw, rip and crosscut table saws furnished all the special equipment needed for the formwork involved. The abnormal speed requirements were met without difficulty by providing 20% more lumber than would otherwise have been required, by a thorough system of routing the forms and by designing them so as to involve the minimum of alterations.

The building was designed for the Midland Warehouse & Transfer Co. by S. Scott Joy, architect, of Chicago. It is being constructed by the Stone & Webster Engineering Corporation, of Boston and Chicago.

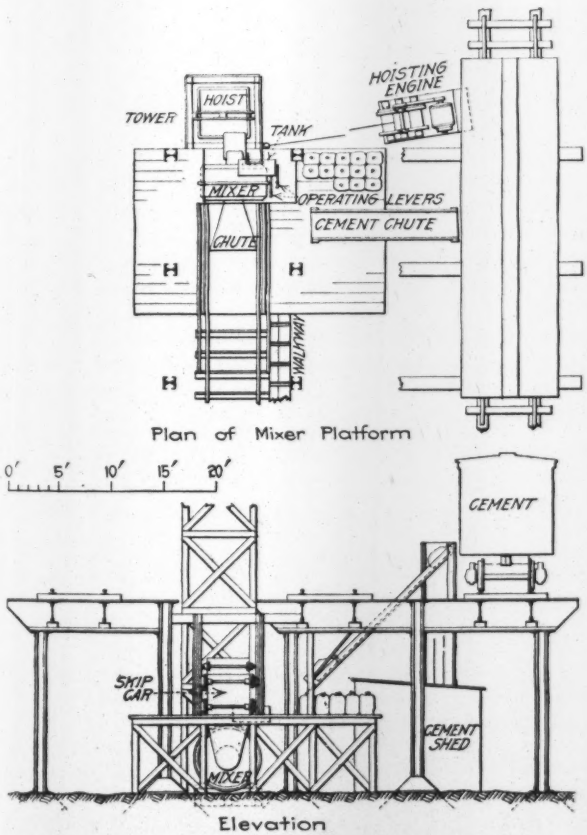


FIG. 4. DETAILS OF CONCRETE MIXER SHOWING CEMENT SUPPLY

A Novel System of Canal Towing has been operated experimentally on the Dortmund-Ems Canal in Germany and is described in a report to the Department of Commerce by United States Consul George Eager, at Barmen, Germany. In this system a line of 40-lb. steel rails is laid along the bottom of the canal and anchored against longitudinal motion by rigid lateral bars spaced about 175 ft. apart. These bars are hinged at their anchorages, thus permitting the rail to be raised from the bottom and even brought to the surface of the water if required. The tugboat has a pair of vertical shafts carrying grooved wheels which grip the rail. The wheels are rotated by the application of power and thus propel the boat forward. The tug is provided with means to grip or release the rail as desired, and also with a propeller for movement in harbors, rivers, etc. In order to provide for traffic in both directions, a double line of rails is laid along the canal. This necessitates the tugs being of sufficiently narrow beam to allow them to pass without dropping the rail.

A System of Foreshore Structures to prevent erosion was completed in July on the south shore of Limon Bay at the Atlantic entrance to the Panama Canal. Three permanent shore dikes were erected with the center one about a quarter of a mile west of the center line of the Canal. The system includes 25 timber groins, which will supplement the dikes in preventing shore erosion and consequent heavy silting in the Canal channel. The three dikes, according to the "Canal Record," are spaced 500 ft. apart c to c. and are parallel to the axis of the Canal. They extend north and south, lying practically at right angles to the original shore line. The longest is 700 ft., the center dike is 400 ft. long, and the third 200 ft. Each is about 8 ft. wide at the top, the sides sloping 1 on 1. The rock used in their construction was obtained from Gaillard Cut. The groins are heavy timber fences built at right angles to the shore line. Each extends about a foot above high water and down the slope of the beach from high-water mark to low-water. Their average length is 100 ft., and they are spaced 400 ft. apart.

Diagrams for Cost of Ties; Canadian Pacific Ry.

Diagrams for the determination of the economic value of ties have been prepared for the use of the engineers and the tie department of the Canadian Pacific Ry., under the direction of J. G. Sullivan, Chief Engineer (Western Lines), Winnipeg, Canada. There are three diagrams, and one of these is given herewith. They are based on a formula given by the Tie Committee of the American Railway Engineering Association in the 1915 "Proceedings" (except that as there printed it includes a typographical error). The formula is as follows:

$$I + A = \frac{CR\,(1+R)^N}{(1+R)^N - 1} = \frac{C\,(1+R)^N}{\dfrac{(1+R)^N - 1}{R}}$$

or

$$I + A = \frac{\textit{Amount of } C \textit{ after } N \textit{ years}}{\textit{Amount of \$1 annuity for } N \textit{ years}}$$

C = Final cost of tie in place;
R = Rate of interest;
I = Interest = $C\,R$;
N = Life of ties in years;
A = Annual contribution to sinking fund, which at compound interest will provide for renewal at end of life of tie.

Example: C = \$1.40. N = 20 years. R = 5%.

From table $(1+R)^N$ = 2.6533 . . log = 0.4237860

From table $\dfrac{(1+R)^N - 1}{R}$ = 33.0660 . . log = 1.5193817

$\overline{2}.9044043$

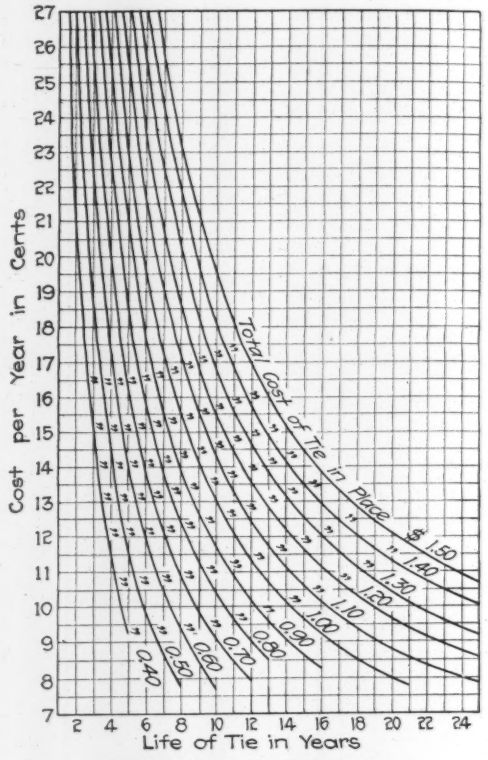
C = \$1.40 . . . log = 0.1461280

log = $\overline{1}.0505323$

$A + I$ = \$0.11234.

The three diagrams show the value of I plus A, from which the annual cost per tie can be taken for ties costing from 40c. to \$1.50 and varying in life from 2 to 25 years. Mr. Sullivan states that they could be made much easier if they only showed the value of A—that is, the amount required to be subscribed annually to form a sinking fund which would purchase a tie. To this would be added direct the interest on the first cost of the tie. This would have a slight advantage over the present form in a case where the cost of the present tie will differ from the estimated cost of the new tie.

The same result, however, can be obtained by taking from the diagram the annual cost, using the estimated value of the new tie, and deducting from this the interest per annum at the given rate on this difference. For example, if it is estimated that it will cost 80c. to renew a tie



COST PER TIE PER YEAR
For ties varying in total cost and in length of life; money figured at 5% interest

which cost in place 75c. and will last 8 years, money figured at 5%, take from the diagram the annual cost of an 80c. tie lasting 8 years, which is 12.4c., and deduct from this the interest at 5% on the difference in the actual cost and the estimated cost of the renewal, 5c., which is 0.25c. This makes the annual cost 12.15c. instead of 12.4c.

With the diagrams are three tables giving the annual cost of ties lasting various lengths of time and costing (in place) various sums. These are figured for money at 4, 5 and 6%. One of the tables is given herewith.

TABLE OF ANNUAL COST OF TIES LASTING VARIOUS LENGTHS OF TIME, COSTING IN PLACE VARIOUS SUMS, MONEY FIGURED AT 5% INTEREST; CANADIAN PACIFIC RY.

Life in Years	Cost in Place											
	$0.40	$0.50	$0.60	$0.70	$0.80	$0.90	$1.00	$1.10	$1.20	$1.30	$1.40	$1.50
1	0.420	0.525	0.630	....	....	....	....	....	....	....	....	....
2	.215	.269	.322	0.376	0.430	0.484	0.538	....	....	....	....	....
3	.147	.184	.221	.257	.294	.331	.368	0.405	0.442	....	....	....
4	.113	.141	.169	.198	.226	.254	.282	.310	.338	0.367	0.396	0.423
5	.092	.115	.139	.162	.185	.208	.230	.254	.278	.301	.324	.345
6	....	.098	.118	.138	.157	.177	.196	.216	.236	.256	.276	.294
7	....	.086	.104	.121	.138	.155	.172	.190	.208	.225	.242	.258
8	....	.078	.093	.109	.124	.139	.156	.171	.186	.202	.218	.234
9	....	....	.084	.098	.112	.126	.141	.155	.168	.182	.196	.210
10	....	....	.077	.091	.104	.117	.129	.142	.154	.168	.182	.195
11	....	....	....	.084	.096	.108	.120	.132	.144	.156	.168	.180
12	....	....	....	.079	.090	.102	.113	.124	.136	.147	.158	.169
13	....	....	....	....	.085	.096	.107	.117	.128	.138	.149	.160
14	....	....	....	....	....	.090	.101	.111	.121	.131	.141	.151
15	....	....	....	....	....	.087	.096	.106	.116	.125	.135	.144
16	....	....	....	....	....	.083	.092	.101	.111	.120	.129	.138
17	....	....	....	....	....	....	.089	.098	.107	.115	.124	.133
18	....	....	....	....	....	....	.086	.094	.103	.111	.120	.129
19	....	....	....	....	....	....	.083	.091	.099	.108	.116	.124
20	....	....	....	....	....	....	.080	.088	.096	.105	.112	.120
21	....	....	....	....	....	....	.078	.086	.094	.101	.109	.117
22	....	....	....	....	....	....	....	.084	.091	.099	.106	.114
23	....	....	....	....	....	....	....	.082	.089	.096	.104	.111
24	....	....	....	....	....	....	....	.080	.087	.094	.102	.109
25	....	....	....	....	....	....	....	.078	.085	.092	.100	.107

Automatic Sewage-Pumping and Metering Station

By Alan A. Wood*

The sewage from Washington Park, a small outlying residential section of the City of Providence, flows by gravity to a point about 100 ft. distant from the Providence River. From here it is lifted against a head of 30 ft. into the settling basins of the precipitation plant at Field's Point, several hundred yards away. The sewage is free from factory wastes. The pumping station is shown in the accompanying figures.

The pumping system is entirely in duplicate. A 12-in. cast-iron main discharges into the pump suction well. From here a Y-connection communicates with two rectangular storage chambers. Each storage chamber has a capacity of about 30,000 gal.; under normal conditions each basin has sufficient capacity to furnish storage for the total flow for a period of 24 hr. The normal dry-weather rate of flow is about 23,000 gal. per 24 hr.; a combined sewerage system is in use, so that this amount is frequently augmented by storm water. Before reaching the pumps the sewage passes through bar screens (bars at 1-in. intervals).

Each chamber serves as the suction well of a 12-in. vertical electrically driven pump with a normal rating of 800 gal. per min. Each pump is driven by a 10-hp. alternating-current motor mounted on the same shaft. The pumps are located below the motors in the basement, and are so placed as to operate under a maximum head of 6 ft. on the suction.

In order to minimize labor cost it was desired to have a plant as nearly automatic in operation as possible. The small volume handled makes it impracticable to run the pumps continuously. Therefore, each motor is equipped with a starting switch operated from a float in the pump-suction basin, automatically starting or stopping the motors when the suction level reaches a predetermined minimum or maximum. This arrangement has operated very satisfactorily for the year and a half in which the plant has been running.

An independent switch on the ground floor of the building controls the starting and stopping of the motors, regardless of the position of the float switch.

*16 Glendale Ave., Providence, R. I.

The apparatus is housed in a neat stucco building. In the first winter some trouble was experienced from freezing, although an attempt was made to heat the building by electric current. This proved expensive as well as unsatisfactory, so that a simple hot-water heating system was installed in its place and the heating problem apparently has been solved.

In order to obtain accurate knowledge of the amount of sewage from this district and to check the operation of the pumps, a 12-in. venturi sewage meter was installed. The venturi tube is placed in the common discharge line from the two pumps and is of sufficient capacity to take the discharge from one pump or from both. The tube is especially designed for this service, being equipped with cleaning devices for preventing the solids from clogging the vent holes and pressure chambers. These have been cleaned once since the plant was installed; early in June of this year about a pint of sludge was removed from the inlet and throat pressure chambers. The small amount of accumulation seems to indicate a tendency for solids to pass through the meter tube and not to adhere to the interior or pass into the vent holes.

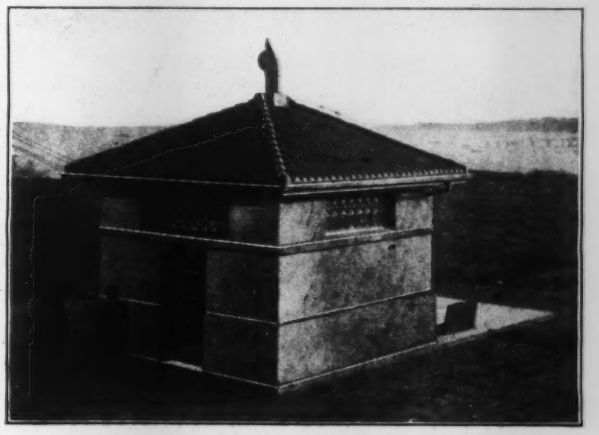


FIG. 1. WASHINGTON PARK SEWAGE-PUMPING STATION, PROVIDENCE, R. I.

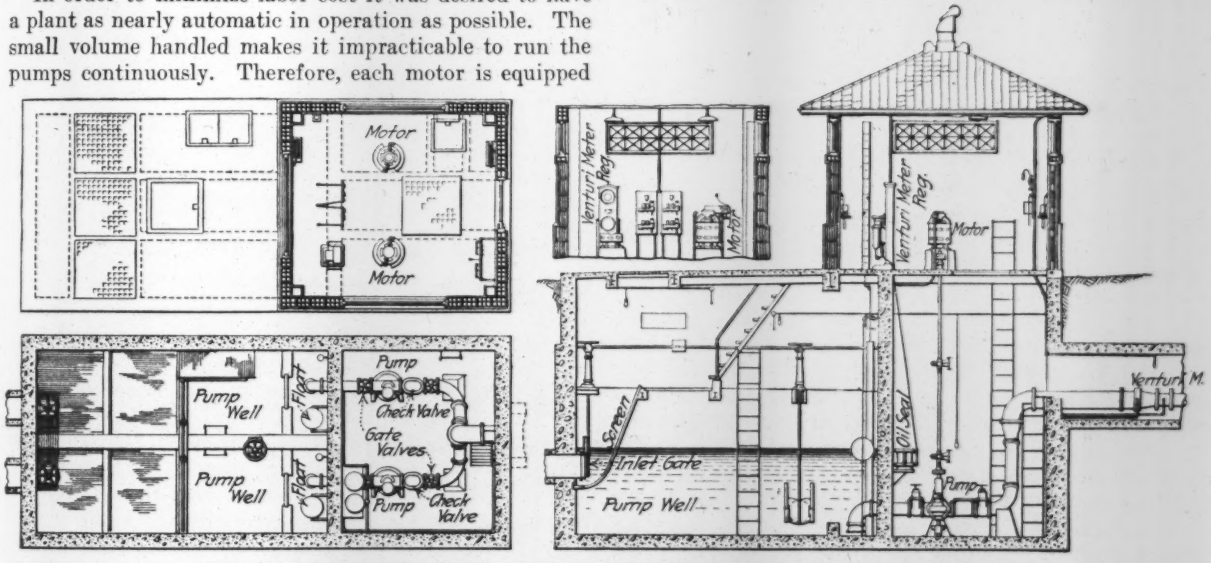


FIG. 2. PLANS AND ELEVATIONS, WASHINGTON PARK PUMPING STATION

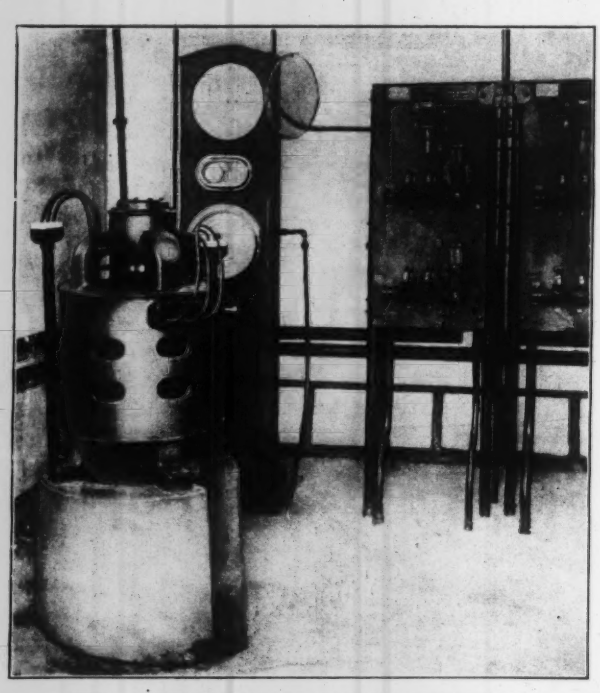


FIG. 3. PUMP MOTOR, VENTURI RECORDER AND CONTROL BOARD

With the venturi tube is employed the register-indicator-recorder shown in Fig. 3. This registers the quantity of sewage being pumped, indicates the rate, and also furnishes a record chart which reveals constantly the condition of the pump. The lower of the three dials is double-graduated, the outer circle indicating, in black characters, the rate in gallons per minute and the inner circle showing at the same time, in red characters, the rate of flow in gallons per 24 hr.

The utility of these charts has been repeatedly demonstrated. For instance, on Sept. 12 the west pump reached a maximum of 930,000 gal. per 24 hr. and maintained while in operation an average rate of pumpage of 750,000 gal. per 24 hr., compared with a rated capacity of 1,150,000 gal. On that day the pump casing was removed and the pump cleaned. On Sept. 13 the west pump momentarily reached a maximum rate of 1,325,000 gal. per 24 hr. and maintained while in operation an average rate of 1,200,000 gal. per 24 hr. Cleaning thus increased the rate of discharge by 42.5% and resulted in a 51.5% saving in current due to the increased efficiency of the pump. On Sept. 12 the pumps were running about ¾ hr.; this time was reduced 20% on Sept. 13.

The total labor charge against the plant, including cleaning of building and caring for heater, taking observations, etc., is the time of one man for 4 hr. per day.

The writer is indebted to the courtesy of Frederick O. Clapp, Assistant Engineer, for assistance in rendering the material for this article available. The plant was designed under the direction of Otis F. Clapp, then City Engineer.

Asphalt and Petroleum in the Philippines—The division of mines of the Philippine Bureau of Science has recently examined the deposits of asphalt in Leyte, which were reported a little more than a year ago. The principal result of this examination was the discovery of a large deposit of rock asphalt near the town of Villaba and at a point very much nearer to the coast than was the original discovery.

Evaporation and Seepage from Irrigation Reservoirs

By Kenneth A. Heron*

The Dallas and Warner reservoirs of the Modesto Irrigation District are formed by a series of low earth dams. When full the reservoirs will have a combined capacity of 28,000 acre-feet, will submerge about 2400 acres, and have an average water depth of a little less than 12 ft. Although constructed four or five years ago, the reservoirs had been used but little before the season of 1914.

When partly full or when water was passing through the reservoirs, the loss in seepage was quite noticeable. To determine just what portion of the reservoir water was lost in this manner, observations were made by the writer in 1914.

Ten borings 100 ft. apart were made. Although these did not reach across the reservoir, it is believed that they disclosed the material under the reservoir bed. All the holes showed a layer of hardpan (not very firmly cemented sand and gravel) from 2 to 8 ft. thick, covered and underlaid with sand, silt and adobe for an average thickness of about 12 ft. Under this was found a stratum of sand from 10 to 40 ft. thick. This in turn was underlaid with a gravel and clay conglomerate to an unknown depth. The hardpan stratum, which if continuous could be depended upon to prevent excessive seepage, is in this locality rolling and broken and of various thicknesses.

The water surface of the reservoirs is from 100 to 120 ft. above the water surface of the Tuolumne River to the south and is considerably above Dry Creek to the north. Each stream is near the reservoirs and each forms an excellent drainage channel for seepage. The great area of water surface and small depth result in a large amount of water being lost in evaporation during the hot summer months, and the large area of porous reservoir bottom submerged offers an underground outlet to vast quantities of stored water.

Records of Evaporation from Reservoir

To determine the amount of water lost through evaporation in the two reservoirs, an evaporation pan (Fig. 1) was placed in the Dallas reservoir. The pan was 3x3 ft. in plan and 18 in. deep, made of No. 16 gage galvanized sheet iron. It was firmly braced with angle irons. In its center, in a vertical position, was placed an iron pin $\frac{3}{16}$ in. in diameter and 12 in. long, with a sharp point. The pan was placed in an opening in the center of a 15x15-ft. float, in such a position that the average top of the water in the pan was even with the water surface of the lake. The float was provided with sides around the edges so as to prevent waves tipping it and was located in such a position that it was under the constant surveillance of the reservoir keeper. Its position was changed from time to time as the water in the lake lowered, and at all times it was kept in such a position as to make the evaporation conditions in the pan as nearly as possible similar to those which acted on the water surface of the reservoir. Records were started by filling the pan with water to the top of the pin. Once a week thereafter and on the last day of each month

*Irrigation Engineer, Modesto, Calif.

water was added with a measure in such an amount as to bring the surface again even with the top of the pin. Records of the amount of water required to do this were kept, as well as the amount of evaporation measured on the pin with a rule. Both methods checked very closely, but the water measurment was assumed as the correct amount of evaporation.

Reservoir Seepage Observations

During the month of May, 1910, the average maximum depth of water in the Dallas reservoir was 3.63 ft., the average submerged area was 310 acres, and the total loss in water depth was 1.14 ft. The recorded evaporation in May, 1914, was 0.425 ft. The seepage is therefore estimated at 0.715 acre-feet per acre of reservoir bottom at an average maximum water depth of 3.63 ft., and this is assumed to be the case at all times when the same conditions exist.

During the season of 1914 gaging stations were maintained above and below the reservoirs and records of inflow and outflow were kept. Gages were observed daily in both reservoirs. The rainfall during February, as recorded by the Grange Co. at Modesto, was 0.406 ft. The February observations are summarized in Table 1.

TABLE 1. EVAPORATION AND SEEPAGE FROM RESERVOIRS, FEBRUARY, 1914

	Mean Area Submerged, Acres	Estimated Evaporation, Acre-Ft.	Seepage, Acre-Ft.	Total Loss, Acre-Ft.	Maximum Depth, Ft.	Acre-Ft. Seepage per Acre Submerged
Dallas Reservoir.	1540	154	8446	8600	19.5	5.48
Warner Reservoir	367	37	1101	1138	6.5	3.00
Total	1907			9738		

During May, 1914, the recorded evaporation from the water surface of the Dallas reservoir amounted to 0.425 acre-feet per acre of water surface. Careful records were kept of all water in the canals during the month and the seepage from the reservoirs as determined is thought

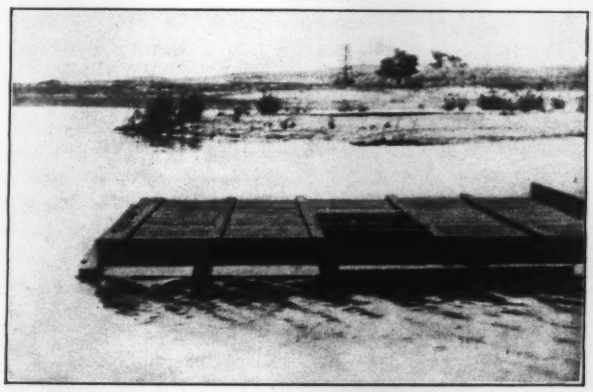


FIG. 1. EVAPORATION STATION NEAR MODESTO, CALIF.

to be very close. Assuming on account of the almost even depth of water in the two reservoirs that the seepage losses in each were proportional to the acreage submerged by each, the losses in the two reservoirs were as shown by Table 2.

TABLE 2. EVAPORATION AND SEEPAGE FROM RESERVOIRS, MAY, 1914

	Mean Area Submerged, Acres	Evaporation, Acre-Ft.	Seepage, Acre-Ft.	Total Loss, Acre-Ft.	Maximum Depth, Ft.	Acre-Ft. Seepage per Acre Submerged
Dallas Reservoir.	730	311	3319	3630	9.1	4.54
Warner Reservoir	367	155	1668	1823	9.5	4.54
Total	1097	466	4987	5453		4.54

It is apparent that these seepage losses are greater as the depth of water in the reservoir increases. From the data a curve has been drawn (Fig. 2) of the estimated mean seepage in acre-feet per acre of reservoir bottom at different average maximum depths of water in the reservoirs.

There is a possibility that the reservoirs will to some extent silt their bottoms and thereby decrease the seepage

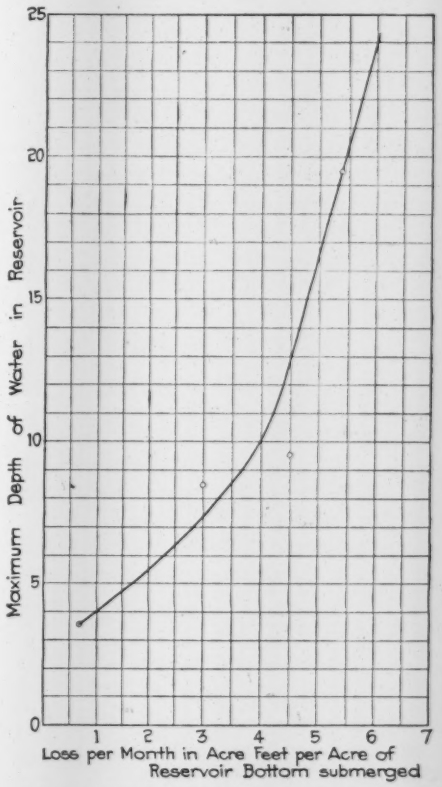


FIG. 2. RESERVOIR SEEPAGE LOSSES

losses. The water passing into them, however, carries very little suspended matter, as can be observed at the lakes at the reservoir intake, where very little sediment is deposited.

A Gasoline-Electric Car equipped with a 200-hp. engine has been built for the New Zealand Government railways by the Midland Railway Carriage & Wagon Co., of Birmingham, England. The car, which is described in London "Engineering" of June 25, is especially noteworthy because it is equipped with the Thomas transmission, an ingenious form of combined mechanical and electrical drive from the engine to the car wheel. The objection raised to the usual form of gasoline-electric drive is that when the engine and car are running at full speed it has a constant percentage of loss due to the conversion of the mechanical energy into electricity in the generator and back again to mechanical energy in the motors. In the Thomas transmission, the electrical generators are used only in starting the car and bringing it up to speed. The construction is such that there is a gradual change from electrical to mechanical transmission as the speed increases. The engine is an eight-cylinder machine of the V-type with a normal speed of 900 r.p.m. and a maximum speed of 1500. From experience with a similar car of 160 hp. in service on the South African Government railways, it is estimated that a fuel consumption of 1 gal. of gasoline per 200 ton-miles' run will be obtained. The car on which this engine is to be placed is 62 ft. 6 in. long and 7 ft. wide. It is to run on a 3 ft. 6 in. gage track and is mounted on two four-wheel trucks. The car with its underframe but without the body weighs 20 tons, of which the motive-power equipment constitutes about eight tons.

Cutting a City Street Through a Railway Station

SYNOPSIS—Cutting through a railway fill to connect two dead-end streets in Springfield, Mass. One street passes under two station buildings.

Springfield, Mass., is noted for long blocks between cross streets. Until recently the most notable examples of this shortcoming were the blocks paralleling the Boston & Albany R.R., which approaches from the northeast and from a geographical point of view cuts the city into nearly equal parts. But three streets formerly connected the northerly and southerly halves of the city in a distance of over two miles, or between the outskirts of the city and its waterfront on the Connecticut River, which flows approximately from north to south.

The main business section of the city lies along and between four streets nearly parallel to the river front and hence crossing the railway at right angles. In this part of the city the tracks are elevated, being carried on an earth fill between masonry retaining walls. Two of the streets had been carried under the railway at the time the tracks were raised, but the other two came to dead ends on each side of the railway fill. One of these was the waterfront street and the other the middle street between the two existing through streets.

The extension of Water St. along the river was complicated by its intersecting, not only the four tracks of the Boston & Albany R.R., but also the ends of two connections—the Boston & Maine R.R. going north on the river bank and the New York, New Haven & Hartford R.R. going south. The extension of the other,

FIG. 2. NORTH SIDE OF UNION STATION, SPRINGFIELD, MASS., BEFORE BEGINNING UNDERPASS

Dwight St., was complicated by its passing through the union station buildings, served by four tracks and used by all three railways. The station is in two parts of almost identical construction, one north and the other south of the tracks, with a covered island-platform between.

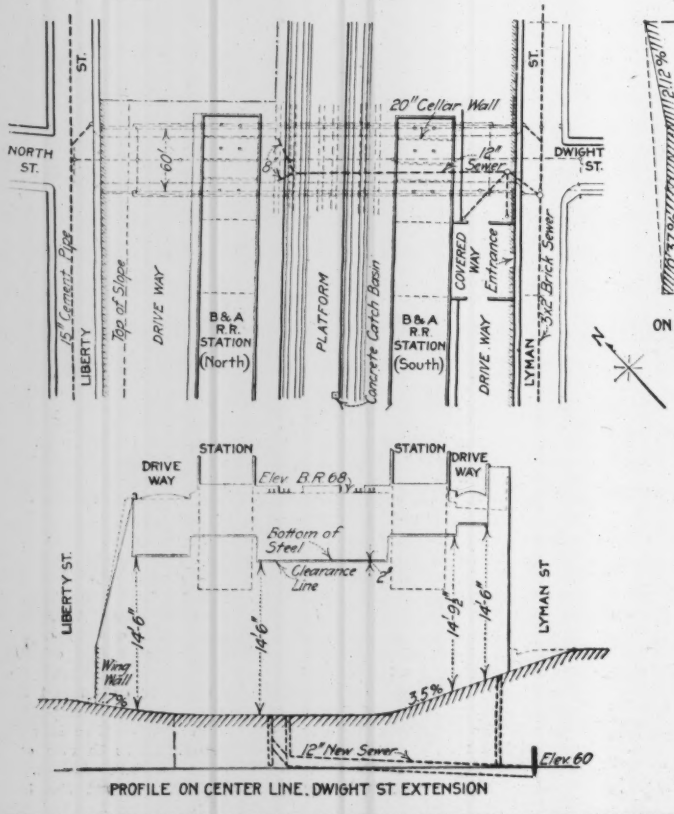


FIG. 1. GENERAL PLAN OF DWIGHT ST. UNDERPASS, SPRINGFIELD, MASS.

The north side of the station at the time of beginning work, March, 1914, is shown in Fig. 2 and the south side in Fig. 3. There was no particular difficulty in connection with excavation under the buildings. The walls and partitions were carried on needle beams and girders made of steel I-beams supported by a trestlework of timbers (Fig. 4). The work at Dwight St. involved the construction of a new refrigerator for the north station restaurant to replace one in the basement and the installation of an electric elevator to replace one of the plunger type; the entire rearrangement of water, steam and sewer pipes and the installation of two Kane gas-fuel boilers to replace the old boilers in the two basements. Temporary quarters had to be provided for the United States mail, two express companies and a news company. The restaurant in the south station was abandoned during construction under this building and the one in the north station was abandoned after the south station had been restored.

The original excavation was only sufficient to build the two abutments (see general plan Fig. 1 and Figs. 5

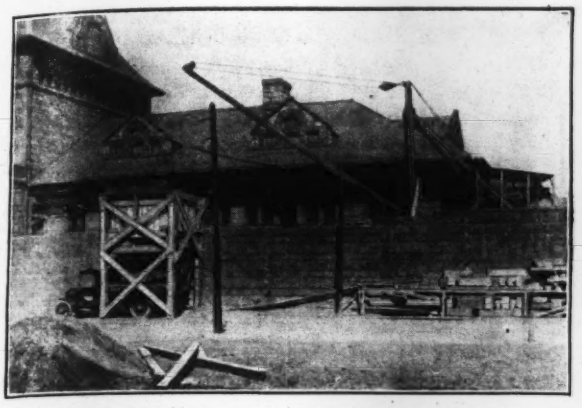


FIG. 3. SOUTH SIDE OF UNION STATION, SPRINGFIELD, MASS., BEFORE BEGINNING UNDERPASS

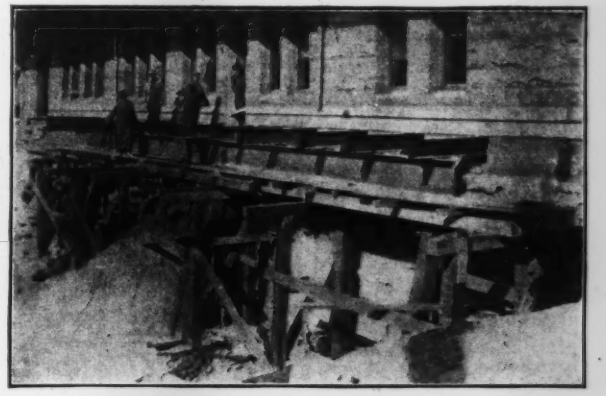


FIG. 4. NEEDLE-BEAMS AND GIRDERS FOR SUPPORTING BUILDING WALLS

and 6). When these were completed the permanent girders under the buildings' walls were placed (Fig. 8) by the use of a locomotive crane and a fixed revolving derrick, after which the excavation between the abutments and under the building was completed.

Before starting excavation under the tracks, piles were driven to from 5 to 10 ft. below the grade of the finished street, to form what might be termed a subterranean trestle. The piles were driven between the ties and the bents capped and stringers placed between train movements without disturbing traffic, notwithstanding there were 300 train movements a day between 8 a.m. and 6 p.m. Only one track at a time was out of commission. No excavation was done except what was absolutely necessary to place the caps and stringers of the trestle and to build the abutments, until the steel-floor system was in place. The backfill behind the abutments was made with wheelbarrows running on the bridge seat before placing the steel. Fig. 9 shows the scheme of excavation.

The steel-floor system (Fig. 7 for detail) was erected in three sections, one at a time, on the completed abutments under the island-platform canopy. The canopy and a pair of tracks were then removed, and by the use of hoisting engines a floor section 22 ft. wide under a pair of tracks was rolled into place. The section for the gap under the island platform was built last. Two weeks was allowed for the concrete of each section to harden before rolling it into place.

For the railway trestle white-oak piles and long-leaf yellow-pine timbers meeting the specifications of the New York Central & Hudson River R.R. (lessees of the Boston & Albany) were used. The cost of driving averaged 27c. per lin.ft., and 7099 lin.ft. of piles were driven. The temporary trestle cost $10,500. No piles were required for the foundations under the abutments, as the material is a hard-packed river sand.

The following are the chief statistics of cost and materials:

Total cost of maintenance, including trestle and station changes	$45,500
Total cost of steel superstructure delivered	67,441
Steel contract, 1601.77 tons	65,160
General contract, including erection of steel	151,250
Mill and shop inspection	720
Total cost exclusive of sewers, paving, land damages and engineering	266,200

Quantities

Excavation	25,735	cu.yd.
Backfilling	5,341	cu.yd.
1:3:5 concrete abutments	5,065	cu.yd.
1:2:4 bridge seats	241	cu.yd.
1:2:4 reinforced concrete	558	cu.yd.
Gunite facing of abutments	1,300	sq.yd.
6-in. tile drain	490	lin.ft.
Reinforcing steel	26,213	lb.
Steel superstructure	1,601.8	tons
Timber left in place	20,790	ft. B.M.
Waterproofing track platform	1,000	sq.yd.
Waterproofing driveway slabs	600	sq.yd.
Total length of Dwight St. underpass	387	ft.
(width)	60	ft.
Length under steel	332	ft.
Clearance under steel	14 ft. 8	in.

The general contractor was the Holbrook, Cabot & Rollins Corporation, Boston, Mass.; the subcontractor for the erection of the steel, was Jobson, Gifford & Co., New York City; the contractor for the steel was the Phoenix

FIGS. 5 AND 6. EXCAVATION UNDER STATION BUILDINGS FOR ABUTMENTS, DWIGHT ST. UNDERPASS

Bridge Co. The engineers were the Samuel H. Pitcher Co., Worcester, Mass.; Earl W. Green, Resident Engineer; and F. C. Freeman, Chief Engineer of the Boston & Albany R.R., who had general supervision of the building of the trestle and restoration of the tracks. Work was commenced Mar. 17, 1914, and completed Dec. 8, 1914, some five months ahead of the contract time limit.

Particulars of Water Street Underpass

The work here was very similar to that at Dwight St., except that it required considerable change in grades of surrounding property and the wrecking of some factory buildings. There are 10 tracks over one abutment and 12 tracks over the other on this underpass, so that the pile trestle to temporarily carry the tracks during excavation was more complicated. The details of the completed structure, however, are much the same as in the Dwight St. structure. The statistics of the Water St. bridge follow:

Total cost of maintenance of tracks, including trestle	$58,500
Total cost of steel superstructure delivered	42,500
Steel contract, 916.45 tons	42,400
General contract, including erection of steel	82,104
Mill and shop inspection	412
Total cost exclusive of sewers, paving, land damages and engineering	184,700

Quantities

Excavation	33,204 cu.yd.
Backfilling	4,308 cu.yd.
1 : 3 : 5 concrete abutments and retaining walls	3,480 cu.yd.
1 : 2 : 4 concrete piers and bridge seats	339 cu.yd.
1 : 2 : 4 reinforced concrete	553 cu.yd.
8-in. tile drain	692 lin.ft.
Reinforcing steel	38,344 lb.
Steel superstructure	916.45 tons
Timber left in place	8,070 ft. B.M.
Impervite facing on abutments and retaining walls	1,175 sq.yd.
Track platform waterproofing	1,500 sq.yd.

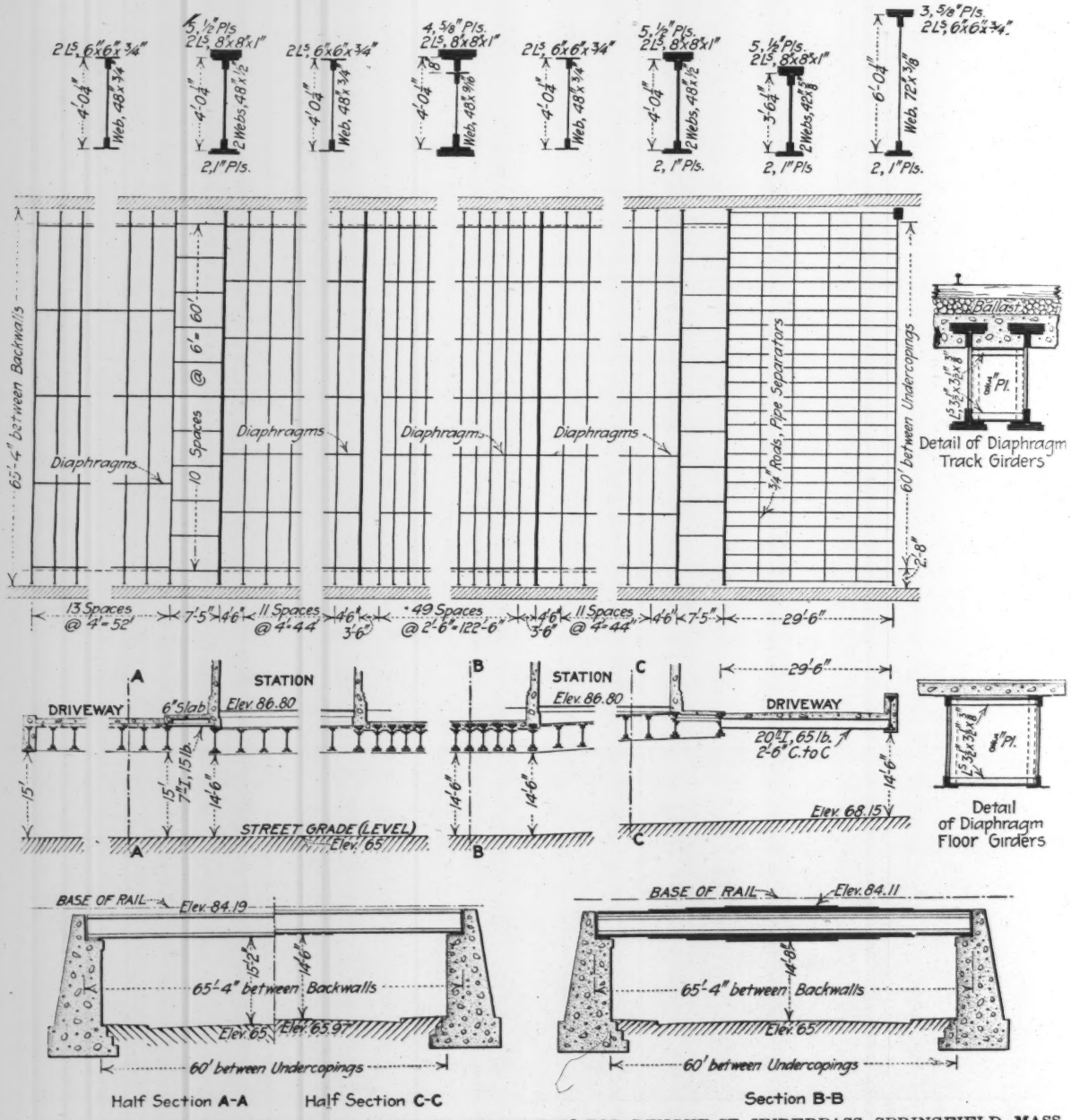


FIG. 7. DETAILS OF CONCRETE AND STEEL FLOOR SYSTEM FOR DWIGHT ST. UNDERPASS, SPRINGFIELD, MASS.

FIG. 8. GIRDER UNDER SOUTH STATION IN PLACE

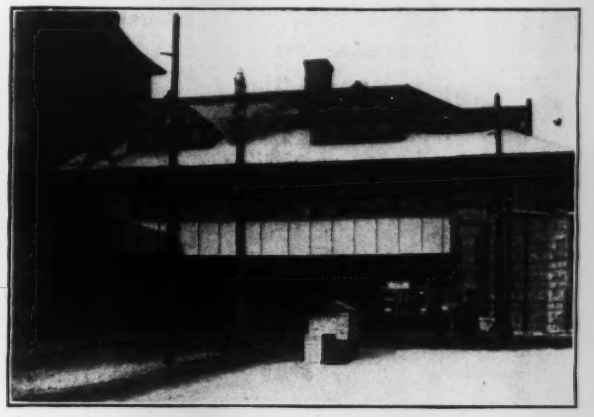


FIG. 10. VIEW OF DWIGHT ST. UNDERPASS COMPLETED

The cost of pile-driving, 36c. per lin.ft., was more than at Dwight St., because there was about 15 ft. more penetration into hard-packed river sand. Some 21,463 lin.ft. of piles were driven. The trestle cost $55,000, the work being done by the Boston & Albany R.R. There was no delay or obstruction to railway traffic during construction; trains were detoured on temporary tracks when necessary.

One section of the steelwork, weighing 225 tons, was erected outside the abutments on falsework, and this was

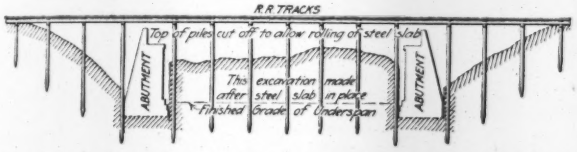

R.R. TRACKS
Top of piles cut off to allow rolling of steel slab
ABUTMENT
This excavation made after steel slab in place
Finished Grade of Underpass
ABUTMENT

FIG. 9. EXCAVATION SCHEME UNDER UNION STATION BUILDING, DWIGHT ST., SPRINGFIELD, MASS.

rolled into place in 9 min. All the rest of the steelwork was erected in place, a section at a time. The steel-and-concrete-floor system complete is 60x191 ft. The clearance over the street is 14 ft. 2 in.

The contractor for the Water St. underpass was the O'Brien Construction Co., New York City. The subcontractor for steel erection was the Perth Construction Co., New York City. The contractor for the steel and the engineers were the same as for the Dwight St. work.

Car-Pullers for Switching at Industrial Plants

The use of car-pullers for shifting railway cars at industrial plants seems to be increasing materially, partly on account of their convenience where only a few cars are handled and partly on account of the charges made by the railways for switching service. Some of these devices have ordinary cable drums, and others have horizontal or vertical winch heads or capstans. The vertical capstans enable the pulling rope to lead off in any direction. The service of some motor-driven and belt-driven car-pullers built by the Stephens-Adamson Co., of Aurora, Ill., is noted below.

At one plant a machine with a 7½-hp. electric motor hauls three 40-ton cars on level track, the length of haul being from 200 to 800 ft. About ten cars are handled daily. A ¾-in. hemp rope gave trouble by breakage, and a ⅜-in. wire cable which replaced it was found to cut the capstan, so that a capstan of chilled cast iron was considered desirable. Another plant uses a belt-driven machine to haul three cars on level track, and handles 12 cars daily. At a third plant, the railway company sets the loaded cars on the switch track, and the car-puller then hauls them singly 100 to 300 ft. to the track scales and thence into the plant. The empty cars are hauled from the plant to the switch track for empties. From 2 to 10 cars are handled daily.

Two motor-driven car-pullers are used at a glass-works to serve the coal-handling plant and the batch-handling and storage plant respectively. The maximum length of haul is about 300 ft. in both cases. The former machine, with a 20-hp. motor, can handle ten loaded coal cars on a slight down grade, and shifts from 6 to 10 cars daily. The latter, with a 15-hp. motor, can haul from 6 to 8 cars on level track, and shifts from 5 to 8 cars daily. Although a switch engine is at the works most of the time, the car-pullers were installed because it was impracticable to call for the engine every time it was desired to move a car.

Electric capstans for shifting cars are used extensively in Europe, but more for railway terminals, dock sidings, coaling stations, etc., than at manufacturing plants.

Timber From the National Forests in Alaska will be largely used for the Alaskan railway structures. The Alaskan Engineering Commission, which is to build the Government railway from Seward to Fairbanks, has received a permit from the United States Forest Service to cut 85,000,000 ft. of timber in the Chugach National Forest. The permit is in conformity with the act of Mar. 4 last, which authorized the Secretary of Agriculture to permit the Alaskan Engineering Commission and the Navy Department to take from the national forests free of charge earth, stone, and timber for use in government works. The timber will be cut in designated areas along the right-of-way of the proposed railroad, which runs through the Chugach National Forest for several miles. Experiments and tests of Alaskan spruce and hemlock are being made at the Forest Service laboratory at Seattle, Wash., and so far have substantiated the opinion of foresters that Alaskan timber is sufficiently strong for practically all structural purposes. While these tests are going on Forest Service employees in Alaska are marking the timber to be cut along the proposed railroad, the cutting to be done so that only mature trees are taken; the young trees being left uninjured and the condition of the forest improved. This cut of 85,000,000 ft. will be the largest amount of timber ever felled in the Alaskan forests in one operation. At the average rate per M ft. b.m. obtained for timber sold from the Chugach Forest during the fiscal year 1914 it is worth approximately $145,000 on the stump. It will be nearly twice as much as the total quantity of national forest timber now cut and used annually for local purposes throughout Alaska.

Mile-Long Highway Tunnel in Pittsburgh, Penn.

Bids on County Highway Tunnel No. 1 which is to extend from East Carson St. near Third St., to Warrington Ave., near Boggs Ave., in Pittsburgh, Penn., were received by the County of Allegheny on July 12. After a consideration of the alternative bids for a brick, a con-

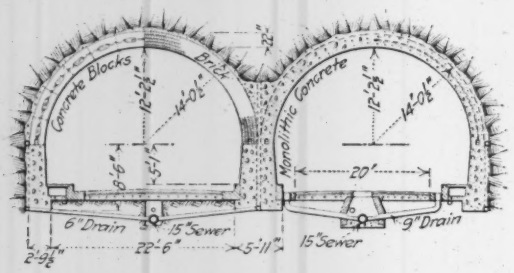


FIG. 1. SECTION THROUGH COUNTY HIGHWAY TUNNEL, PITTSBURGH, SHOWING ALTERNATIVE LININGS

The monolithic concrete lining shown in the right-hand arch is to be used

crete-block and a monolithic-concrete lining, the contract was awarded to Booth & Flinn, Ltd., 1942 Forbes St., Pittsburgh, for the monolithic lining at a total cost of $1,347,018.50. The accompanying drawings give the details of the design and the accompanying table the alternative bids of the successful contractor, with the range of bids submitted.

The tunnel will be 4875 ft. between portals with open-cut approaches, bringing the total length up to 5800 ft. It is in twin section, with two roadways each 20 ft. wide and two sidewalks each 2 ft. 9 in. wide. Ample provisions

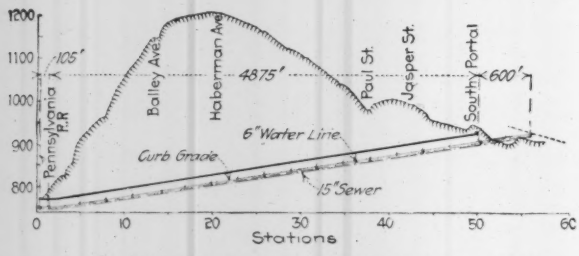


FIG. 2. PROFILE OF COUNTY HIGHWAY TUNNEL, NO 1, PITTSBURGH

are made for drains, conduits, sewers, etc. The alternate designs shown in the drawing called for a lining of concrete block, of brick or of monolithic concrete. Although the successful bidder submitted a lower price on the concrete-block, a consideration of the subject resulted in the acceptance of the monolithic-concrete lining. It will

BIDS ON COUNTY HIGHWAY TUNNEL NO. 1, ALLEGHENY COUNTY, PITTSBURGH, PENN.

	Successful Bid of Booth & Flinn, Ltd.		Range of Unsuccessful Bids	
Tunnel Proper:	Cost per lin.ft.	Total Cost	Cost per lin.ft.	Total Cost
Brick lining	$280.00	$1,365,000	$279–417	$1,360,125-2,032,778
Concrete-block lining	229.50	1,118,812	268–435	1,306,500-2,120,625
Monolithic-concrete lining	235.00	1,145,625	251–420	1,223,625-2,047,500
Approaches		201,393.50		164,543- 298,950

be noted that up to the springing line of the arch all three of the designs were the same.

Work on construction is about to start under the direction of the county authorities. A. D. Neeld, of Pittsburgh, is Consulting Engineer.

Improvements in Small Coaling Stations

In the smaller class of railway coaling stations, serving a limited number of locomotives, it is especially desirable to keep the cost of construction and operation low, the latter being attained by making the operation as nearly automatic as possible. Two recent developments in this direction are described herewith. Both are specialties of the T. W. Snow Construction Co., Chicago, and the car-unloading device is the invention of A. B. Seaverns of that company.

Coaling Station with Car Unloader

A common arrangement is for the cars to dump the coal into a track hopper, from which it is fed by gravity to a conveyor which delivers it to the overhead bin. The pit and underground construction add considerably to the cost of the plant, particularly in wet or bad ground. The new Snow coaling station (Fig. 1) dispenses with all this underground work and takes coal directly from

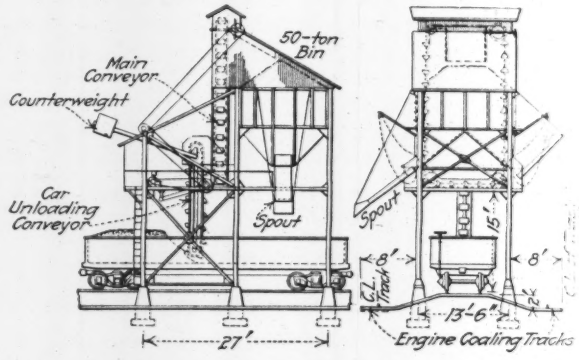


FIG .1. COALING STATION WITH UNLOADING CONVEYOR

the cars. Less storage capacity is needed when coal is held on the cars in this way, so that there is a saving also in the height and size of the structure.

The bin is carried by a structure spanning the coal track, and has an inclined bottom delivering through flexible spouts to engines standing on either side. At one end of the structure is a platform on which is mounted a bucket conveyor, which has a vertical movement within guides and is carried by a counterweighted lever. It stands normally about 15 ft. clear of the track, so as not to foul cars. When a coal car is spotted in position, the conveyor is lowered into it to excavate the coal, being swung laterally, in order to cover the entire width of the car. The car is moved forward as the unloading progresses. Only about 10 per cent. (or less) of the coal has to be shoveled into the conveyor buckets.

The movable conveyor delivers coal to a fixed conveyor, traveling at right angles to it, which elevates the coal and dumps it into the storage bin. An operator on the platform controls the height and the lateral swing of the unloader conveyor, and by means of a drum and cable governs the movement of the coal car. The apparatus can handle any size of coal up to 6-in. lumps. It has a capacity of 50 tons per hour. Similar equipment has been supplied for a sand-and-gravel-handling plant.

The hoist shown in Figs. 2 and 3 is designed for coaling stations of the double-bucket type, in which the loaded bucket ascends, while the empty bucket descends. The

special feature is that the drum is driven by a worm gear running in oil, so that in the event of power being cut off or because of some other accident the heavy loaded bucket (with 1 or 2 tons of coal) cannot overhaul the hoist and drop.

In the general view of the new hoist (Fig. 3) the large gear wheel for the drum is inclosed in the circular casing, beneath which is the cylindrical casing for the worm. At the left is the connection to the shaft of the motor or engine. The bevel gears for driving the worm shaft in opposite directions are inclosed in the rectangular box, at the side of which may be seen the clutch mechanism. A winch, or niggerhead, for a cable hauling cars on the coal track is mounted on the drum shaft. There is a clutch connecting the drum to the shaft; but this clutch cannot be released so long as there is a strain on the drum cable. Ordinarily the shaft is longer than that shown (to put the niggerhead in a convenient position and clear of the hoist mechanism), and has an outer bearing on a concrete pier or pedestal.

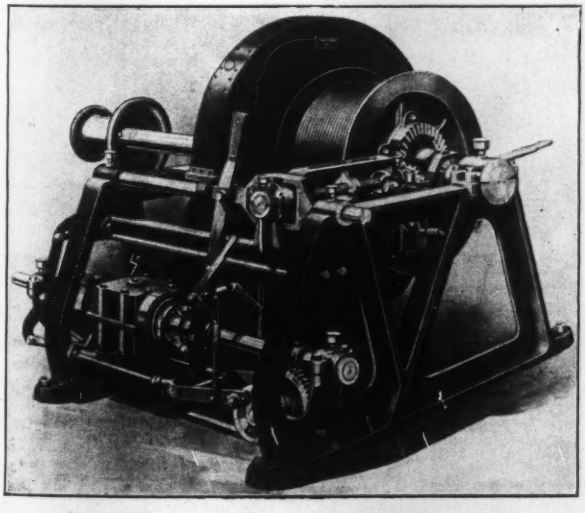


FIG. 3. AUTOMATIC REVERSING HOIST

The controlling mechanism is of interest. The bevel gear on the face of the drum drives a threaded shaft on which rides a nut, having a projection engaging the frame *B*. At the end of its travel the lug on the nut engages a stop lug, and the nut is then revolved with the shaft, turning the frame, and with it a cam, which shifts the clutch shaft laterally. Through the clutch lever this shifts the clutch to the neutral position. This constitutes an automatic stop. The stop lug can be turned on the threaded shaft for adjustment of the position of the stop.

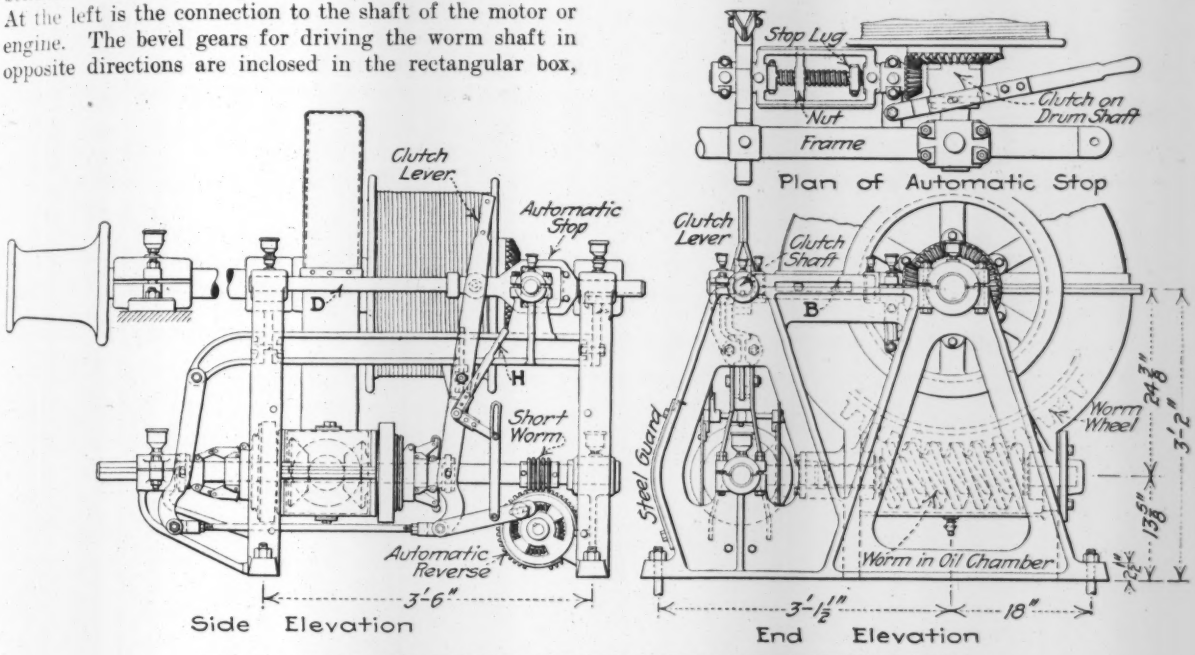


FIG. 2. DRIVE AND CONTROL DETAILS, AUTOMATIC REVERSING HOIST

For the automatic reverse, the driving shaft carries a short worm, engaging a worm wheel the teeth of which are cut away at two opposite points on the circumference. A link connects this wheel with the clutch lever. The movement of the lever to the stop position (by means of the device described in the foregoing) thrusts this link forward so as to turn the gear wheel far enough to engage the worm, and the wheel then makes a half revolution, pulling the link over so as to move the clutch lever and put the clutch into reverse position.

When this is effected, the wheel is again freed from the worm by its interrupted gear. The hoist then makes its reverse movement, is again automatically stopped, and again automatically reversed. The clutch lever can be operated by hand, and a bell-crank provides for disconnecting the link from the automatic reversing mechanism.

In the type of coaling station using these hoists the railway cars dump the coal into a track hopper, from which it is delivered to the buckets alternately through gates which are opened and closed automatically by the motion of the buckets.

Railway Mileage in Argentina amounts to 22,826 mi., of which 559 mi. were added in 1914, according to the annual message to Congress of the President of Argentina. The State railways were increased by 200 mi. during 1914, giving a total mileage of 3209, of which 2908 mi. are narrow-gage.

Stripping Water-Works Reservoirs

By Frederic P. Stearns*

SYNOPSIS—A study of data for unstripped New York reservoirs and stripped Boston reservoirs, combined with general considerations, leads the author to conclude that stripping large reservoirs lessens organic growths and improves the quality of the water. The benefit in a given case may or may not warrant the necessary outlay.

Engineering News of May 6, 1915, contains an article on "Stripping Water-Works Reservoirs," by Allen Hazen and George C. Whipple, which leads the writer to think it advisable to present some other phases of the subject of reservoir stripping.

He wishes to state at the outset that there are many instances where the conditions are such that stripping the surface soil from a reservoir would not produce good water, and other instances where the cost may not be warranted, notwithstanding the excellent results to be obtained from this practice; but that there are still other cases where stripping is desirable.

The writer will follow the precedent set in the article referred to and make comparisons between the unstripped reservoirs of New York and the stripped reservoirs of Boston.

The Object of Stripping

The main purpose of stripping is to diminish the food supply for microscopic organisms and in this way restrict their growth in the reservoir, and especially the summer growths, which cause so much taste and odor in the water of unstripped reservoirs. A secondary, but important, purpose is to prevent the water from taking up the soluble organic matter or the products of decomposition of the organic matter, and particularly to prevent the putrefactive decomposition which takes place in the bottom of deep unstripped reservoirs in the summertime. The stripping of large reservoirs also improves the color of the water and its chemical composition, features which will be referred to subsequently.

Many misleading comparisons have been made between stripped reservoirs, unstripped reservoirs and natural ponds because of a failure to take into account the possibility that the food supply may be contained in the influent water, independent of the environment of the reservoir.

Importance of Food Supply

The importance of the food supply is generally recognized when the influent water comes from the ground, because it has been so well demonstrated that ground water contains a food supply sufficient to develop abundant growths of organisms, even when the water is stored in a clean, uncovered distributing reservoir.

It is not so generally recognized that influent water from surface sources may also contain an ample food supply as the result of a large population upon the drainage area, of the flooding of unstripped reservoirs, or, in cases where the streams become turbid after rains, of the washing into the reservoir of the surface soil from the drainage area.

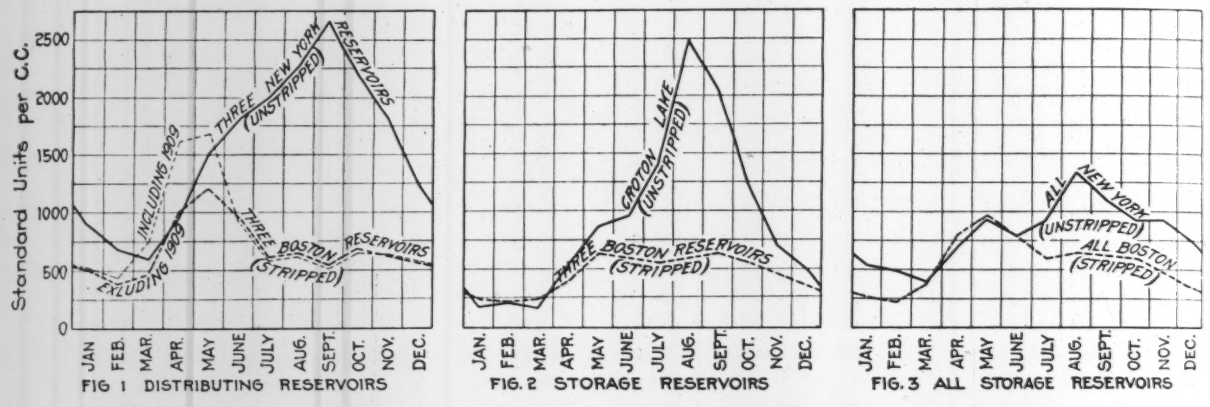


FIG 1 DISTRIBUTING RESERVOIRS FIG. 2 STORAGE RESERVOIRS FIG. 3 ALL STORAGE RESERVOIRS

ORGANISMS IN UNSTRIPPED NEW YORK RESERVOIRS AND IN STRIPPED BOSTON RESERVOIRS

Where there is an ample food supply in the influent water, stripping will not prevent abundant growths of organisms; but it is effective when the reservoirs are fed by clear-water streams flowing from drainage areas containing only a limited population.

An instance of the effect of a change in the amount of food supply in influent water is furnished by Lake Cochituate of the Massachusetts Metropolitan Water-Works. This is a natural lake which originally had an area of about 560 acres, but was raised, without stripping, about 67 years ago to nearly its present level, increasing the area to 776 acres. Because of the long lapse of time since the raising took place, it is probable that the effect of the unstripped portion is small. There has been a very large increase in the population upon the drainage area, with a consequent increase in the food supply for organisms. The effect of the increased population has been intensified since 1908 or 1909 by the low flow of the streams during all the years since that time. The result has been a very great increase in the number of microscopic organisms, as is shown by the following comparison, in which the increase in the amount of

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chlorine above the normal amount in this location gives an approximate measure of the increase in food supply:

Date	Excess of Chlorine Above the Normal	Standard Units of Microscopic Organisms per C.C. Surface	Bottom
1893-1900	0.25	741	592
1901-1910	0.28	1107	909
1911-1914	0.46	3406	5400

By improperly using the recent records of this lake in comparison with the records of unstripped reservoirs one might reach the misleading conclusion that a natural lake is inferior to an unstripped reservoir, although there is abundant evidence that natural lakes in unpopulated districts are far superior under normal conditions.

Messrs. Hazen and Whipple have classed the distributing reservoirs in Central Park as stripped reservoirs, although it is evident that where the water in a reservoir is frequently changed it can, in the long run, make little difference in the food supply whether the reservoir has a concrete lining or is an unstripped natural reservoir, because the water could not continue indefinitely to take up an appreciable amount of food from the bottom. The organisms in such reservoirs obviously obtain their food from the influent water, and in the case of the Central Park reservoirs this water comes from unstripped reservoirs. These distributing reservoirs should, therefore, on account of the source of the water, be classed as unstripped rather than as stripped.

Massachusetts Metropolitan Reservoirs

The whole history of the stripped reservoirs of the Metropolitan water-supply has made it clear that the water held in and supplied from stripped reservoirs, when not affected by the bad character of the influent water, not only does not promote the abundant growth of microscopic organisms at any season of the year, but practically prevents the abundant growth of the summer organisms which are so likely to give water an unpleasant taste and odor.

There has been, however, one exceptionally abundant growth, occurring in one reservoir in one year, although the total experience with the Ashland, Hopkinton, Sudbury and Wachusett reservoirs of this supply aggregates 74 years. This exceptional growth was one of Asterionella in the Wachusett Reservoir, which started in the autumn of 1908, the year the reservoir was first filled to high-water mark, and developed in large numbers from February to June, 1909.

Water from the Wachusett Reservoir is discharged into the Sudbury Reservoir, thence into Framingham Reservoir No. 3, and thence into the distributing reservoirs of the Metropolitan District, and consequently all of these reservoirs contained a large growth of Asterionella, which had been supplied to them from the Wachusett Reservoir. The growths did not originate in these reservoirs.

In any tables or diagrams of the numbers of organisms, a growth of Asterionella would have as much weight as the same number of other organisms of the same size, although there are many other microscopic organisms, such as Synura, Uroglena and Anabæna, Aphanizomenon and other blue-green algæ, which would produce stronger and more disagreeable odors when in smaller numbers.

Messrs. Whipple and Jackson have published a table[1] which shows that it takes a very large number of Asterionella to produce more than a faint odor. A part of this table follows:

Odor	Number of Asterionella per. C.C.
Faint	1,000 to 5,000
Distinct	3,000 to 15,000
Decided	10,000 to ....

Messrs. Hazen and Whipple, in their comparisons of the numbers of organisms in the New York and Metropolitan water-supplies, state that although "different kinds of organisms produce different tastes and odors and in different amounts," the plottings show only the gross number of organisms, rated as standard units. They also state that "for a part of the period covered by these records, copper sulphate has been used in the New York reservoirs from time to time," and add that "this has, no doubt, tended to reduce somewhat the growths of organisms in the New York reservoirs."

The comparison of the numbers of organisms is of importance mainly as a measure of the tastes and odors of water, but in drawing their conclusions no allowance appears to have been made either for the difference in the character of organisms, as affecting the tastes and odors, or for the effect of the copper sulphate used in the New York reservoirs, although none was used in the reservoirs of the Metropolitan supply.

The character of a water supplied to a community is best shown by the character of the water in the distributing reservoirs from which the water is drawn for use. Fig. 1 is based on monthly records for the three distributing reservoirs of the City of New York in Central Park for the years 1903 to 1914 and for the three principal distributing reservoirs of the Metropolitan water system for substantially the same period. For Boston two lines are given, one including and the other excluding the year 1909, when the abnormal growth of Asterionella occurred. During the first four months the results do not differ very much and the number of organisms is not large, but in the remaining months the number of organisms in the New York reservoirs is much greater, the maximum in these reservoirs being fully four times as much as in the Boston reservoirs during the same month. This wide difference in the hot weather is important, because it is the time when the more objectionable organisms develop in large numbers in the waters of unstripped reservoirs, and because the tastes and odors caused by the organisms are much more noticeable in warm than in cold weather.

New York and Boston Reservoirs

Fig. 2 shows a comparison between the number of organisms in Croton Lake from 1903 to 1908 inclusive and in the three completely stripped reservoirs of the Metropolitan water-supply for the same period.[2] As before, the upper line represents the New York records, and the lower line the average of the three Metropolitan reservoirs for the same period. Substantially the same results are reached by comparing the storage reservoirs as by comparing the distributing reservoirs.

Fig. 3 shows a comparison between the numbers of microscopic organisms in the New York and in the Boston storage reservoirs, based upon all available records

[1] "Jour. New England Water Works Association." Vol. XIV, p. 12.

[2] The numbers in Croton Lake are taken from the report of the Department of Water Supply, Gas and Electricity for the year 1908, p. 48, which contains the only printed statement of monthly records available to the writer. All other monthly records of the New York supply referred to in this article are taken from tables, or scaled from diagrams, prepared by Messrs. Hazen and Whipple.

which it seems proper to use. The New York records cover all years when observations were made, from 1903 to 1913 or 1914, and include observations at the surface of the Old Croton Lake and the New Croton, Croton Falls, Cross River, Muscoot, West Branch, Titicus, Bog Brook, East Branch, Middle Branch and Boyd's Corner reservoirs, representing in all 1383 monthly records.

The Boston records cover all years when observations were made, from 1893 to 1914, and include the Wachusett, Sudbury, Hopkinton and Ashland reservoirs, which were fully stripped, and Framingham Reservoir No. 3, which was partly stripped—representing in all 1107 monthly records.

This comparison shows the same general characteristics as the others, but the differences are somewhat smaller, owing in part to the inclusion in this case of the older New York reservoirs from which much of the food supply furnished by the soil in the bottom has been exhausted.

It should be borne in mind that these diagrams do not show the full difference between the normal number of organisms in the waters of the two places, because the number of organisms in the New York supply has been diminished by the use of copper sulphate in the storage reservoirs and by the chlorination of the water in the Croton Aqueduct on its way to the distributing reservoirs.

Opinions of Consumers

Thus far the comparison has been made of the gross number of organisms of all kinds, although these are not a satisfactory measure of the tastes and odors of waters, which is really the comparison desired. The opinions of the consumers as to the taste and odor of the water furnished are the true criteria as to the effect of stripping or nonstripping, but as the consumers do not publish their opinions, they are best reflected by the statements which may be found in the water reports. Reference is made to the tastes and odors of the Boston water in all the Metropolitan reports from 1904 to 1914 and in the New York reports beginning in 1909. The Metropolitan reports indicate that in ten years out of eleven, the exceptional year being 1909, there was little or no complaint from the water takers. The New York reports indicate that complaints are the rule rather than the exception. Brief extracts from the reports follow:

NEW YORK REPORTS

1909. Microscopic organisms increased greatly and caused several complaints. Aphanizomenon has been the chief offender, and has been the source of disagreeable tastes and unsightly scum in bath tubs. It has also interfered with the small sand filters installed in apartment houses and hotels.

1910. In the latter part of August complaints about the disagreeable taste and odor in the water became frequent, this condition of the water being caused by the heavy growth of Aphanizomenon, the microscopic algæ growth which imparts a very disagreeable taste and odor to the water.

1911. These growths (of microscopic organisms) were, however, sufficiently numerous to give a decided taste and odor to the water and cause some complaint. The Aphanizomenon algæ was the main cause of the taste and odor.

1912. Report not available.

1913. Objectionable tastes and odors, due to microscopic growths in the distribution reservoirs, especially in Central Park, have disagreeably affected the quality of the water.

METROPOLITAN REPORTS

1904. The organisms (in Wachusett Reservoir) have not been abundant . . . In the Sudbury Reservoir and in Framingham Reservoir No. 3 the microscopic organisms were more abundant in the latter half of the year than usual, causing an odor which was quite persistent, and which was reported from week to week by the biologist. The odor did not, however, become sufficiently strong to cause complaint from the water takers.

1905. In the Wachusett Reservoir there has been an increase, as compared with the previous year, in the number of organisms, but they were not such as to cause disagreeable odors.

In the Sudbury Reservoir and Framingham Reservoir No. 3 the microscopic organisms, while quite abundant, gave no trouble.

1906. In the Wachusett Reservoir the number of organisms has been small throughout the year, and never of a character to give the water an objectionable taste or odor.

In the Sudbury Reservoir the number of organisms has been much larger than usual, . . . causing at times an objectionable odor. The odor disappeared before the water reached the gate-house at the lower end of Framingham Reservoir No. 3.

1907. The number of organisms present (in the Sudbury Reservoir) was not sufficient to cause objectionable taste and odor in the water delivered to the Metropolitan District.

1908. A small growth of Uroglena was present in the Sudbury Reservoir in January, but it did not cause a noticeable taste in the water supplied to the district.

1909. Early in the year a growth of the microscopic diatom Asterionella developed in the Wachusett Reservoir. The numbers of the organism gradually increased, and as the water from the Wachusett Reservoir was delivered into the Sudbury and Framingham No. 3 reservoirs growths of the organism appeared in those reservoirs, and early in March were present in the water delivered to the consumers in sufficient numbers to cause complaints of a geranium taste and odor. . . . From the first of April until the middle of June the water drawn from the taps, with the exception of that supplied from Spot Pond to the northern high-service district, had a very disagreeable taste and odor. . . . . After July 1 the water delivered to the district was unobjectionable for the remainder of the year.

1010. The water in the Wachusett and Sudbury reservoirs and Framingham Reservoir No. 3 . . . . has been almost entirely free from organisms causing objectionable tastes and odors. . . . No complaints have been received from the water takers.

1911. The number of microscope organisms present in the water has also been somewhat above the average, but there has been no growth of organisms of sufficient magnitude to cause objectionable tastes and odors in the water as drawn from the taps. . . . The water has been generally of good quality and very few complaints have been received from the water takers.

1912. The number of microscopical organisms present in the water has been above the average, but the water supplied to the district has not contained objectionable tastes or odors in sufficient degree to cause complaint.

1913. Small growths of Uroglena, Chlamydomonas, Dinobryon and Synura have occurred in the several distributing reservoirs and for short periods have given the water a slightly unpleasant taste, but very few complaints of the quality of the water furnished have been received.

1914. Objectionable microscopic organisms have been present in several of the reservoirs, but not in sufficient numbers to cause objectionable tastes and odors in reservoirs from which the supply was drawn.

Source of Seeding

It has frequently been stated that the water discharged from the Croton Aqueduct is seeded in the Central Park reservoirs, and that this seeding accounts for the abundant growths of organisms in these reservoirs. The writer's experience leads him to believe that trouble from this cause would not continue for any long time if the influent water did not contain an abundant food supply for organisms from the unstripped reservoirs.

A similar trouble occurred in one of the distributing reservoirs of the Metropolitan system, which had for many years before the Metropolitan supply was turned into it been used for the storage of ground water, and consequently had contained abundant growths of organisms. Before turning the Metropolitan water into this reservoir, it was cleaned as well as practicable in view of the granite-block paving laid without mortar on the sides of the reservoir; but enough of the deposits of organic matter remained in the interstices of the paving

to supply sufficient seed and food to produce abundant growths of organisms in this reservoir for a year or two after the new water was turned in. After this time, the growths became more limited, and soon corresponded to those in the other Metropolitan reservoirs.

It has been stated that the effect of stripping is not permanent, and that organisms and other organic matter will drop to the bottom of the reservoir and soon form a deposit which affects the water in the same manner as the soil originally upon the reservoir bottom. The latter part of the statement is based largely upon examinations of deposits on the bottom of unstripped reservoirs, or of distributing reservoirs supplied from unstripped reservoirs. There appears to be no ground for supposing that similar occurrences will take place in connection with stripped reservoirs which do not receive a food supply or a supply of organic matter with the influent water, or that such reservoirs will ever deteriorate except as the result of a change for the worse in the character of the influent water.

Progressive Improvement of Water

Many observations have shown that natural lakes and ponds which have been in existence thousands of years, and which are supplied with good water, contain water which is even better than that of stripped reservoirs in respect to the number of miscroscopic organisms, tastes and odors. There seems to be no reason why all deep reservoirs, whether stripped or unstripped, supplied with water of the character stated, should not ultimately reach the condition of the lakes and ponds which have been in existence for so long a time.

Stripped reservoirs will furnish good water in the beginning, and still better water at subsequent periods, and unstripped reservoirs will furnish much poorer water at first, but ultimately the character of the water will be the same as if the reservoirs were stripped. How long a time this will take is not definitely known. Many reservoirs show a great improvement in from ten to twenty years, but some, like the Ludlow Reservoir at Springfield, Mass., show little improvement at the end of forty years.

The Ashland Reservoir was first filled in 1886. Twenty-one years later, when it was drawn down 23 ft. below high-water mark, the writer examined the bottom of the reservoir and found it to be free from deposits except in some small hollows and flat places immediately below the inlet.

Another test of the permanence of the favorable conditions due to stripping is shown by the number of microscopic organisms in the Ashland and Hopkinton reservoirs, which have been recorded in standard units from January, 1893, and May, 1894, respectively:

	Ashland	Hopkinton	Average
First quarter	98	550	324
Second quarter	363	471	417
Third quarter	415	365	390
Fourth quarter	499	399	449

These reservoirs now have an average age of 25 years, and the average number of microscopic organisms in them in the last two years has been only 341, which does not indicate that they are deteriorating.

Vertical Circulation

It is well known by those engaged in water-supply problems that in the summer the surface water of deep reservoirs becomes warmed, while that toward the bottom remains cold, so that there is no circulation from the surface to the bottom. Under such circumstances the character of the bottom water depends largely on the presence or absence of organic matter. If decomposing organic matter is present in large quantities, as for instance, in unstripped reservoirs, all of the dissolved oxygen in the water near the bottom becomes exhausted, and the water is deeply stained and foul smelling. The foul odors result from the putrefactive decomposition of the organic matter, and are largely due to the presence of sulphureted hydrogen. The stain is due in part to the iron dissolved in water of this kind.

Such bottom water is offensive if drawn from the reservoir during the period of stagnation, and affects the quality of the water at all depths when the vertical circulation takes place in the autumn. The stagnant layer in the bottom of normal stripped reservoirs and deep lakes contains dissolved oxygen and does not become stained or offensive. For instance, the writer has drawn water in September from the stagnant layer 100 ft. below the surface of the Wachusett Reservoir, and the water has been as clear and free from stain as that at the surface, entirely free from taste and odor, as cool as spring water and entirely palatable.

Mr. Whipple states in his book on "The Microscopy of Drinking Water" that he "once collected a sample from Lake Champlain at a depth of nearly 400 ft. The temperature was 39.2 deg.—i.e., maximum density—and the water was probably in a state of permanent stagnation. The sample was bright, clear, colorless, and without odor. The material on the bottom was found to be almost perfectly clean gravel."

Color and Chemical Composition

The water stored in the Wachusett Reservoir is effectually decolorized, the average change in the color from the inlet to the outlet being from 44 to 15, a reduction of 66 per cent. The decolorization would have been far less if the reservoir had not been stripped.

The change in the chemical composition of the water by storage in the Wachusett Reservoir is indicated by the records from 1908 to 1914:

	Parts per Million	
	At Inlet	At Dam
Residue on evaporation:		
Loss on ignition	14.4	11.5
Fixed residue	24.3	18.8
Total residue	38.7	30.3
Albuminoid ammonia	0.158	0.128
Oxygen consumed	4.7	2.6

The table shows a decided improvement in the chemical composition of the water, while there are many instances of a decided deterioration in the chemical composition of water caused by storage in unstripped reservoirs.

The favorable showing made for stripped reservoirs when there is a proper comparison of the stripped Boston reservoirs with the unstripped reservoirs of the New York water-supply may be supportetd by a proper comparison of many other stripped and unstripped reservoirs.

From the writer's point of view, the question between stripping and not stripping reservoirs which are supplied by clear-water streams and unaffected by a large population on the drainage area is not whether the water will be materially improved by stripping but whether the cost of stripping is warranted. The water in the reservoir will be of much better quality if the reservoir is stripped, but the cost of stripping may be too great. The problem should be solved for each particular case.

Superstructure of Chicago Municipal Pier

SYNOPSIS—Details of methods of erecting steel and making and pouring concrete on new city pier in Lake Michigan at Chicago. Notable for long distance chuting of concrete.

The new Chicago municipal pier,[1] extending 3000 ft. into the lake, has on each side a steel-frame two-story shed with concrete floors and concrete slab roof. These two sheds are each 2340 ft. long by 100 ft. wide, and are separated by an 80-ft. driveway with concrete slab base. Their construction requires the placing of about 40,000 cu.yd. of reinforced concrete (with 1300 tons of steel bars) and 6700 tons of structural steel. The contractor for this part of the pier is Edward L. Scheidenhelm, of Chicago, and the contract price is $1,091,800.

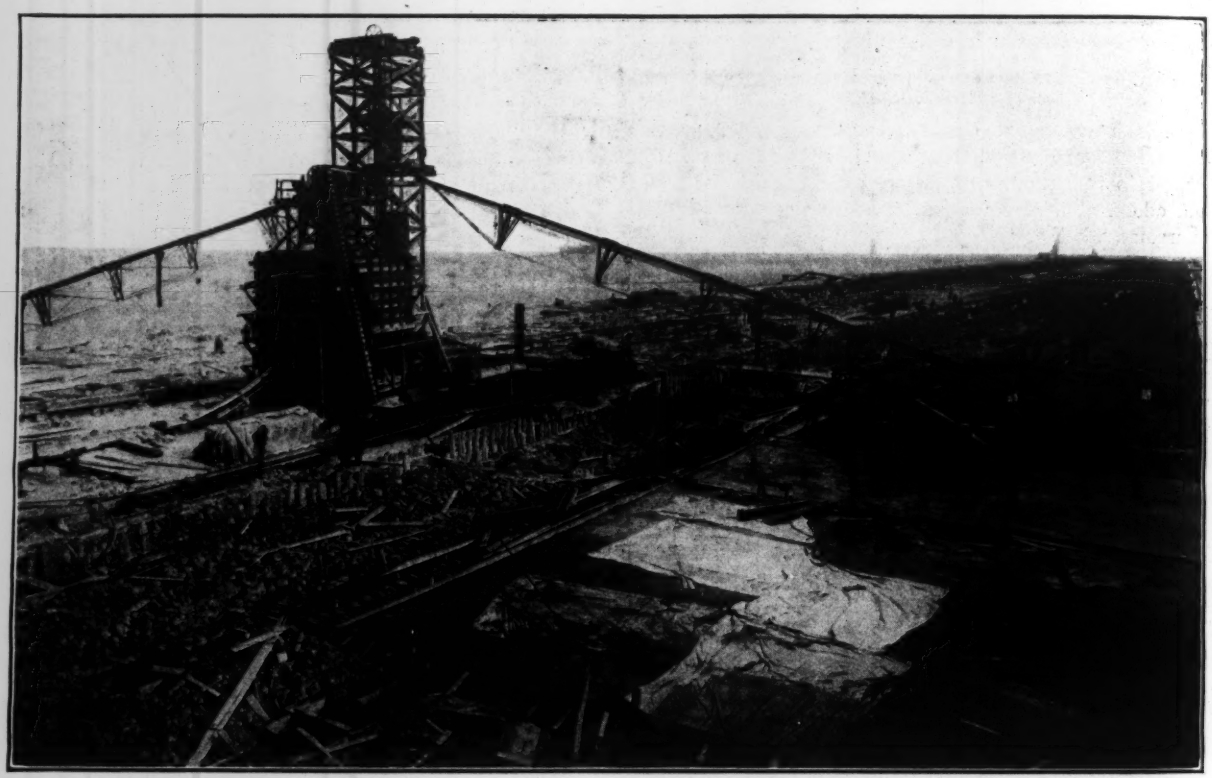


FIG. 1. CONCRETING PLANT FOR THE FLOOR AND STEAMER SHEDS OF THE MUNICIPAL PIER AT CHICAGO

The plant is shown placing the concrete deck in advance of the steel superstructure. At the center is the traveling mixer outfit, with the bucket elevator for stone and sand, and the belt conveyor in the rear for the sacks of cement. At the front end is the tower for the concrete elevator, with the 120-ft. distributing spouts on either side. Hanging from the spouts will be seen the vertical pipes for delivering concrete at intermediate points. One of these at the right is discharging to an extension chute. At the side of the outfit is the material track, raised on a "hump" at the hopper from which the bucket elevator raises the material. At the left are the piles of sand for spreading over the clay fill to level the surface and form the base for the concrete slab. Beyond the concreting plant, on both sides of the pier, may be seen the discharge pipes from the suction dredges, extending over the concrete wall and making the interior fill.

The contractor's material yard is at the side of a slip opening from the river. Crushed stone (from ¼ to 1 in. in size) is delivered by deck scows, the stone being carried in 3½-yd. wooden skips or boxes piled upon the deck. A steam stiff-leg derrick, with an 80-ft. boom, mounted on a platform above the ground, picks up each box separately, swings it over the top of the stock pile and lowers it to rest so that the chain sling is slack. A man on the pile then unlatches the end door and unhooks one loop of the sling, so that the derrick raises the box by one end, and the stone is discharged.

Torpedo sand from the St. Joseph River, in Michigan, is delivered by a large steel suction-dredge, or sand-sucker, with hopper of 100-cu.yd. total capacity. Locomotive cranes on its deck pick up the sand with 1½-yd. grab buckets and dump it upon a belt conveyor on a pivoted boom swung out from the side of the vessel. This conveyor deposits it in the stock pile. Beneath the stock piles is an inclined belt conveyor 270 ft. long. The sand and stone, in adjacent piles, are fed directly upon the conveyor, which delivers the materials into an elevated bin having hopper-bottom compartments for 20 yd. of stone and 20 yd. of sand.

The material is handled from the bins to the mixer plant in 12-car trains of 1½-yd. side-dump steel cars. These ride on tracks of 36-in. gage laid with 45-lb. rails and wood ties. A 16-ton four-wheel saddle-tank locomotive handles the trains. Because of the large amount of

[1] "Engineering News," July 29, 1915.

timber in falsework and forms, the smokestack of this engine is fitted with a tall wire cylinder as a spark arrester. The engine, when it brings back a train of empty cars, is uncoupled and switched off, leaving the cars to run into a siding. The engine is then coupled to a train of cars standing on the track under the bin. These it moves forward gradually, and each car is loaded (with sand or stone as required) by means of a slide-gate in the hopper. The engine then takes this train out on the pier, while the empty train is backed onto the loading- or bin-track by means of a crab and cable.

At the mixer the track is raised by blocking to form a hump or long vertical curve. The engine hauls its loaded train over this hump, pushing before it the empty train through a switch, and then couples onto this empty train to haul it back through a siding past the hump track. A cable leads from a drum on the mixer plant to a snatch-block and then back along the track. This is hitched to the train of loaded cars and pulls it back over the hump, each car being dumped at the summit to deliver its contents into a hopper at the side of the track.

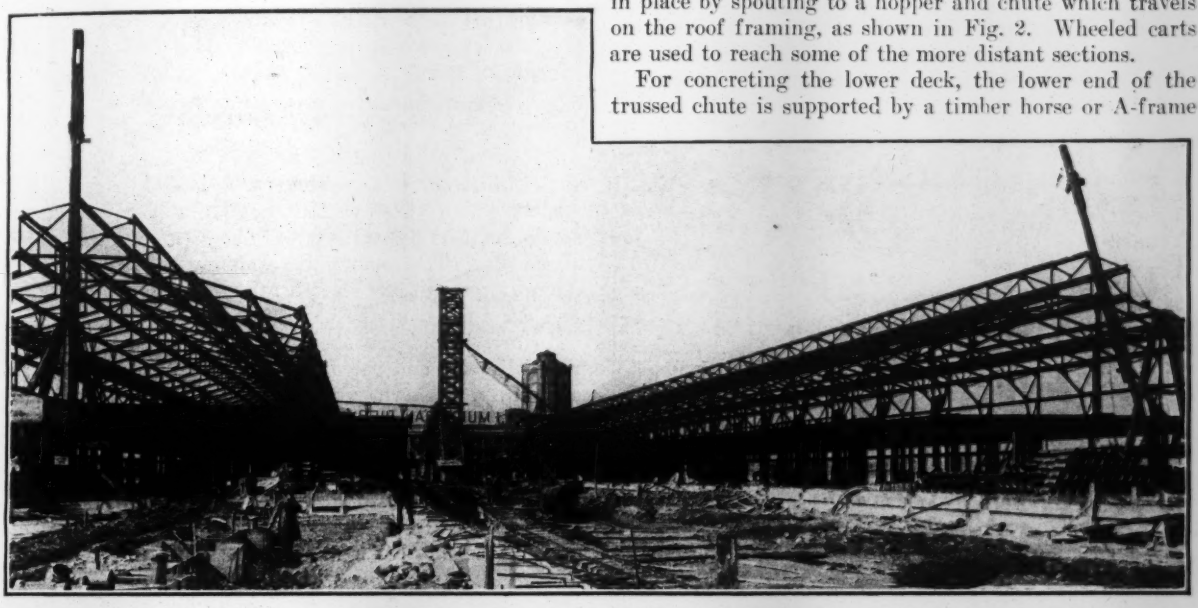


FIG. 2. ERECTING THE STEEL SUPERSTRUCTURE AND CONCRETING THE UPPER DECK OF STEAMER SHEDS

The two derrick cars, with 60-ft. booms are placing the steel work. Between the sheds is the traveling concreting plant, with one 120-ft. chute delivering to a hopper and spout which travels on the roof framing and discharges the concrete into the floor forms.

Cement is brought out in horse wagons and motor trucks, which are hauled out easily on the finished concrete deck. The sacks of cement are wheeled to a platform behind the traveling mixer plant. From this storage pile they are thrown upon a belt conveyor which carries them to the mixer floor.

The mixer plant is a timber structure about 14x28 ft., 30 ft. high, having an elevator tower 8 ft. square and 125 ft. high. It weighs about 45 tons. This outfit is supported by rollers on plank runways laid on the sand fill, and is moved ahead by a cable attached to an anchor pile and operated by the drum mentioned above. The machine is moved about 300 ft. at a time (at intervals of seven days), and makes this move in about four hours.

At the rear of the machine is a bucket elevator raising the sand and stone from the hopper to the elevated bins, which hold 80 yd. of stone and 80 yd. of sand. The mixer is of 1-yd. capacity, mounted on the lower deck, and delivers the concrete into a 1-yd. elevator bucket. At the proper height this is tripped and dumped sideways to discharge the concrete into a hopper fitted with a gate and a flexible-pipe spout leading to the discharge chutes. The equipment of the mixer outfit includes a 20-hp. motor for the mixer, a 15 hp. motor for the stone bucket elevator, and a 100-hp. motor for the tower elevator. This concreting plant is shown clearly in Fig. 1.

From each side of the tower projects a trussed frame 120 ft. long, carrying the sheet-iron chute. The frame is trussed horizontally also to give it lateral stiffness. The upper end of each frame and the hopper within the tower are raised and lowered by cables passing over sheaves on top of the tower. For the upper deck of the sheds and for the roof slabs (which were poured in forms on the completed upper deck) the concrete is delivered in place by spouting to a hopper and chute which travels on the roof framing, as shown in Fig. 2. Wheeled carts are used to reach some of the more distant sections.

For concreting the lower deck, the lower end of the trussed chute is supported by a timber horse or A-frame 8 ft. high, mounted on small wheels. From this, portable lengths of sheet-iron spouting are carried on light timber falsework and blocking. At the outer end of the floor, the slope of this spouting is rather slight, and men push the slushy concrete along with hoes. With a 1-yd. mixer and elevator bucket, handling a batch about every minute, the delivery of concrete from the chute is almost continuous. The bottom of the trussed chute has two trap openings, with flexible pipe spouts to deliver concrete at intermediate points. The trap swings up, so as to block the chute.

In advance of the concreting, pits are dug in the fill for the column footings over the foundation pile clusters, and trenches are cut for the longitudinal girders between the footings. Light timber forms are placed in these, with forms also for pedestal footings where required. The rods are cut and bent on the work, and are held in place by blocks and wiring.

The space between the girder forms is leveled off and the clay fill covered with a bed of sand, and over this is

placed the network of reinforcing rods for the slab. The concrete is deposited in the trenches and upon the sand and is worked into place with hoes, while the surface of the slab is leveled by means of shovels. This will be covered with a cushion bed of sand for 3-in. creosoted-block paving in the sheds.

For the flat-slab upper deck, the bottom form is supported by timber falsework in the usual way, and the surface of the concrete is troweled to form the finished floor. After this floor has set, it is covered with sheet-iron plates and a layer of roofing paper, and rectangular forms are placed upon it for the 4-in. roof slabs. These are 3 ft. 4 in. by 8 ft., and weigh about 1500 lb. each.

An iron loop is set in each end of the slab for attaching a chain sling. The slabs are hoisted and set by a small traveler moving along the roof framing and having its cable led to a hoisting engine on the deck below.

Erection of Steel Framing

The structural-steel framing of these sheds is erected by a traveling stiff-leg derrick with 60-ft. timber boom and operated by a 30-hp. steam engine. This backs out along

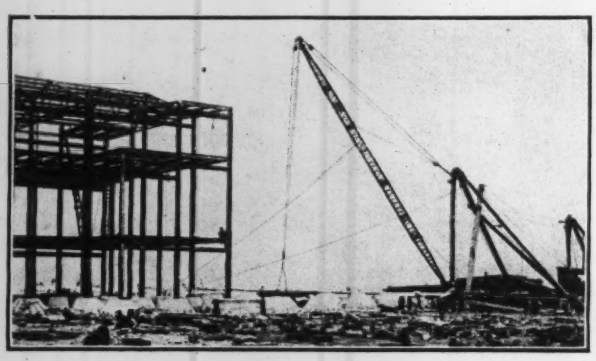


FIG. 3. ERECTING STEEL FRAME FOR TERMINAL BUILDING

the pier, placing material as it goes. This work is done by the Kelly-Atkinson Construction Co., Chicago, under a subcontract.

The lower deck consists of columns and I-beam framing, while the upper deck has three-hinged arch trusses of 68-ft. span. Each half truss is assembled and riveted up on the site and then raised into place, the outer end being supported temporarily on a vertical shore, with a screwjack at the base to allow of adjusting the ends of the adjacent half trusses to receive the crown-pin. The 60-ft. boom has a maximum vertical reach of 55 ft., so that it can place not only the trusses but also the monitor-roof framing above them. The heaviest loads handled are about 6000 lb. The steelwork, which is delivered on the site by wagons, will total about 7000 tons.

Erection of the Terminal Building

This is a steel frame building on the pier, at the end of the sheds previously described, and about 2500 ft. from the shore. Its construction is not included in the work so far mentioned. The John Griffiths & Son Co., of Chicago, has the contract. The construction plant, with the partly finished structure, is shown in Fig. 3.

The steel was erected with a derrick having a 90-ft. steel boom. The trusses were delivered all assembled complete at the shop. All the steel was brought out on scows to the site of the building, and was unloaded with a derrick, which was a part of the scow. The stone, sand and cement for the concrete were brought out to the site on derrick scows and unloaded with clamshell buckets operated by the derricks. The concrete is not spouted in place, but hoisted to the different floors with building hoists.

An Earthquake-Proof Concrete Tower

A gate tower 229 ft. high for the Calaveras reservoir of the Spring Valley Water Co., San Francisco, Calif., was designed recently by A. V. Saph for the particular purpose of getting an earthquake-proof structure. The tower is located close to the upstream toe of the hydraulic-fill dam, a short distance to one side of an arch culvert which carries storm water through the dam during construction. The Calaveras fault line is near by, and as this is believed to be a center of tectonic earthquake shocks, it was necessary to make the tower strong enough to withstand earthquakes.

Earthquake Intensity

The tower was designed at every horizontal section of sufficient strength to withstand a lateral push on the structure above that section equal to a horizontal acceleration of 6.44 ft. per sec., or one-fifth the acceleration of gravity. This makes the computation simple, as the lateral forces are just one-fifth the corresponding weights, and are applied at the centroids of those weights.

In arriving at the above-stated value of acceleration, the California and the Japanese earthquake studies were gone over. Omori, who has made a classification of Japanese earthquakes, classifies as No. 4 those earthquakes which have a maximum acceleration of 2000 mm. per sec. per sec., in which all factory chimneys are broken, and most of the ordinary brick buildings partly or totally destroyed, etc. This corresponds to Class B of the scale of the California Earthquake Commission, which is defined as comprising "fairly general collapse of brick and frame buildings when not unusually strong; serious cracking of brickwork and masonry in excellent structures; the formation of broad wavelike folds in paved and asphalt-coated streets," etc. The symptoms described were taken by the designer of the tower as defining the most severe earthquake to be expected in California, though not as violent as the most severe observed in Japan, where it is reported accelerations as high as 10,000 mm. per sec. per sec. occurred.

In designing a chimney for a pumping station in San Francisco on rock, the city specified an acceleration of 6.2 ft. per sec. per sec., practically identical with that assumed here. It is worth noting that structures on rock foundations suffer less in earthquakes than structures on soft ground. The gate tower will also rest on rock foundation.

Tests were made on low brick piers fixed to a shaking table. The piers broke near the base at an acceleration which on the average was 0.8 of the calculated breaking acceleration, computed from other tests of the strength of the brickwork, assuming that on the shaking table there is a "gradual application" of the force. On the other hand, it has been noticed that chimneys destroyed in earthquakes broke a little above midheight, and only

rarely were they damaged near the base; so that the strength of the tower near its middle may be regarded as the critical element. This midheight strength being sufficient to resist an acceleration somewhat greater than that of the assumed earthquake, the tower is safe throughout its height.

The chief other question considered was the period of vibration. In strong earthquakes the period of the earth movements is below 1 sec. for the principal movements. To avoid resonance effects, which might lead to indefinite multiplication of the stresses, it was aimed to make the period of vibration of the tower as far different as possible from the period of earth movement. The tower's natural period is 1.03 sec. (tower empty in air) to 1.45 sec. (tower full of water in air). However, the damping effect of the water surrounding the tower will probably make the question of period of vibration relatively unimportant.

For protection against the destructive effects of resonance, the upper part of the tower shell was increased in thickness on the recommendation of Prof. Charles Derleth from 12 in. to 18 in.; the periods previously given apply to the heavier section. Further, to give a larger margin of strength for any chance resonance effects, additional circular and longitudinal steel was placed in the shell beyond what was required on the basis of the acceleration calculations.

Proportions of Tower

The tower, 220 ft. high above the base and 229 ft. high above rock, is of 20 ft. inside and 28 ft. outside diameter at the base, and of 10 ft. inside and 13 ft. outside diameter at the top. The footing slab is octagonal, 50 ft. in least diameter and 9 ft. thick. Both inner and outer faces are built to a smooth taper, on the ground that offsets would form definite planes of weakness, while a cylindrical inside would mean either unduly large diameter at the top or too small a diameter at the bottom. The tapered form also gives lower center of gravity and decreased water displacement, hence greater effective weight of the tower.

Stresses under the maximum assumed earthquake conditions were taken at 20,000 lb. for the steel and 730 lb. for the concrete. A gravel concrete equivalent to 1:2:4 mixture is specified to be so made as to have a 28-day strength of 2000 lb. per sq.in. The steel was proportioned for the computed stresses, except that it was nowhere allowed to fall below 0.25% (increased on Professor Dereleth's recommendation to 0.33%). The longitudinal steel averages from 0.3% to 0.4%; in the lower section of the tower it consists of an inner ring of forty 1-in. square rods and an outer ring of forty 1¼-in. and forty 1-in. rods; at the top it consists of an inner ring of twenty ⅝-in. and an outer ring of forty ⅝-in. square rods. Circumferential reinforcement is arranged in inner and outer rings, ranging from ⅞ in. square to ⅝ in. square and spaced uniformly 12 in. apart vertically. The steel is kept at least 4 in. inward of the concrete surface.

The horizontal reinforcement was designed for resistance against collapse of the shell under the horizontal forces due to earthquake acceleration. The steel was proportioned by an arbitrary formula for moment as follows:

$$M = 7.5\,Ad$$

where A is the area of the cross-section of tower in square feet, and d is the diameter in feet. This formula, Mr. Saph states, represents the resistance of a ring 1 ft. high to the action of the stated acceleration acting on a ring 4 ft. high. No further account is taken of the horizontal shear transmitted by the part of the tower above the section under consideration.

Full Tower or Empty Tower

As originally designed by Mr. Saph, the tower was to be empty or dry, the outlet pipe extending down through it from gate-controlled inlets at various levels. The choice of the empty tower was determined by the belief that the water in a full tower would add to the possible earthquake effect.

In reviewing the report, Prof. Chas. Derleth took the opposite view, holding that a full tower would be safer as regards earthquake effect, and he laid great stress on the fact that a full tower is free from all possibility of trouble by uplift, and hence is also safer against sliding. He therefore recommended detailing the tower as a full tower, to contain water standing at reservoir level. This recommendation was adopted by the company.

Tests of Fireproofed Wood

At the recent annual meeting of the National Fire Protection Association, the Committee on the Uses of Wood in Building Construction presented an extended report[1] dealing with tests made of wood treated with various fire-retarding compounds at the Government Forest Products Laboratory in Madison, Wis. These tests were made under the direction of Robert E. Prince and included also tests of the relative inflammability of various species of wood untreated and of various paints claimed by their manufacturers to have a fire-retardant effect.

The conclusions arrived at as a result of the tests may be briefly summarized as follows: The widely held idea that certain kinds of lumber are much more resistant to fire than others was not supported by the results of Mr. Prince's tests. It should be said, however, that his tests were made on the soft woods such as are in general use for building construction. It is of course recognized that the hard woods are less easily ignited than the woods from most evergreen species, but this is not a fact of practical importance, since the hard woods are generally unsuitable for exterior use.

Turning to the tests on lumber fireproofed with various chemicals, it was found that some of these chemicals injured the strength of the wood or discolored it, and had a corrosive effect on the cylinders used for treating. The best results in fire retardation were obtained from wood treated with ammonium salts and sodium borate. These chemicals are obtainable at prices which are not a serious handicap to the use of wood treated with them. The fire-retardant paint tests showed that a number of these paints have considerable value in decreasing inflammability, especially those which are designed for interior use. Extended tests were made also with various methods for reducing the inflammability of shingle roofs, and it was found to be practicable to effect this by various methods at a reasonable cost.

[1]The committee report has been reprinted as a separate pamphlet and can be obtained from the Secretary of the National Fire Protection Association, Franklin H. Wentworth, 87 Milk St., Boston, Mass.

Maintaining Concrete and Brick Roads in Illinois

By B. H. Piepmeier

SYNOPSIS—Gives a description of the methods of maintaining concrete and brick pavements on state-aid highways in Illinois, for which a special motor truck was made by rebuilding a small runabout; also by the use of a hand-drawn kettle. Gives cost data on practically all the more important state roads.

Inasmuch as the Illinois state-aid road law requires the state to stand the whole upkeep cost, the State Highway Commission has deemed it advisable in the majority of cases to have the roads constructed of some of the more durable types of pavement, such as brick and concrete. The state-aid routes are the main traveled thoroughfares and will necessarily require considerable attention, even when constructed of the most durable types of pavement.

The highway law has been in effect but two years, and there has been, in round numbers, only about 100 miles of road constructed under state supervision and with state aid, so it would seem at first thought that the upkeep cost on these roads would be almost negligible at this time. It is indeed expected that the maintenance cost will be very light the first few years, but it is quite important that the roads should receive such attention as is needed.

The 100 miles of pavements that have been constructed are widely separated in many different counties

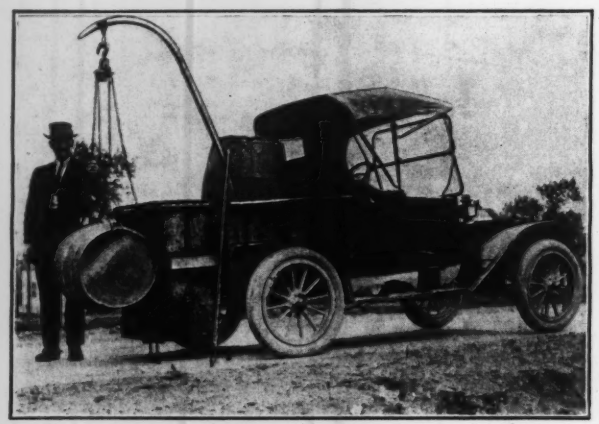


FIG. 1. SMALL MOTOR TRUCK FOR CONCRETE ROAD MAINTENANCE, ILLINOIS

of the state. However, about 50 per cent. of the concrete pavements are within a radius of 75 miles of Chicago, or within the Northeast division. The other six divisions of the state have both concrete and brick pavements, widely scattered.

Equipment for Maintenance Work

On account of the present small mileage of improved roads as well as their wide distribution throughout the state, it was thought expedient to furnish a small portable heating kettle, steel broom, heavy barn broom, a scratching tool and pouring can to only four of the seven divisions; two of the divisions being able to borrow from

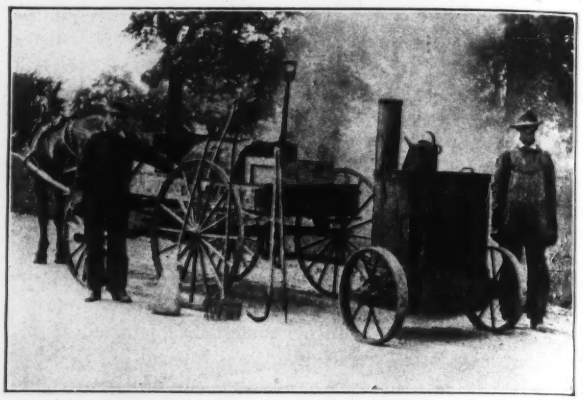


FIG. 2. PORTABLE HEATING KETTLE FOR CONCRETE ROAD MAINTENANCE, ILLINOIS

adjoining ones, and thus take care of the necessary work for the next two years.

The Northeast division, which has about 50 per cent. of the state-aid concrete pavements, is provided with a small motor truck for maintenance work. The principal use of the truck is to transport the necessary heating apparatus, bituminous filler and sand. The maximum load that is transported to different sections of road does not exceed 1000 pounds. A light truck that could be easily converted into a car for use of the division engineer was considered the most satisfactory.

For this service a Ford runabout has been equipped by replacing the rear hood with a 42x36-in. demountable body (Fig. 1). To the lower corners of this body are attached 3x3x3/8-in. angles, which project in the rear sufficiently to support a 32x30x16-in. heating kettle. In the corner of the body a socket is provided for holding a light derrick equipped with a differential chain block for hoisting drums and barrels of bituminous material into the truck and for dismounting the heating kettle when other use of the car is desired. The derrick is made so that one man can handle any load he wishes to put into the truck, and it can be removed easily and carried at a suitable place under the body of the car. On account of the load the car is required to carry, oversize tires (31x4 in.) with demountable rims are placed on all four wheels.

The rectangular heating kettle mounted on the rear of the truck has a tight-fitting lid. Beneath the kettle are mounted six standard cup gasoline burners, supplied from the car's gasoline tank. Gasoline is used for heating the bituminous material in preference to other fuel, largely on account of its weight, cleanliness and convenience.

It has been found that about 1 gal. of gasoline will supply sufficient heat for one day's work. The burners

•Maintenance Engineer, Illinois State Highway Department, Springfield, Ill.

may be started quickly and when the bituminous material is once hot, a single burner will keep it at the proper temperature throughout the day. The burners work satisfactorily while the car is running, so there is practically no time lost in getting the material heated. When the car is needed for other use, the kettle is dismounted and a small gasoline can is hooked to the side of the kettle and connected with the burners by a short hose.

Details of Operation of Truck

A great deal of dependence can be put in the efficiency of maintenance with this truck, for an expert can be placed in charge of the work. The expert then is the only laborer to do and supervise a majority of the work. On account of the delays in shipping the kettle from place to place, it is not always convenient to have an expert follow it. The division engineer merely directs the shipping of the equipment and arranges with some local men to do the work in accordance with his directions. However, under this scheme the division engineer is required to give considerable of his time to maintenance work.

Materials Used in Repair Work

The State Highway Department during the last four years has investigated the use of various materials for

STATE OF ILLINOIS

STATE HIGHWAY DEPARTMENT

UPKEEP COST ON STATE AID ROADS

.....*County*, *Route*..... *Sec*.....

DESCRIPTION: Length...Ft; Width...Ft; Sq. Yd...; Built...191, Total Length Longitudinal Cracks...Ft; Transverse...Ft; Joints...Ft;

COST OF MAINTAINING SLAB, JOINTS, CRACKS, ETC.

DATE	COST OF MATERIALS							COST OF LABOR		COST OF TRANSPORTATION					ESTIMATED DEPRECIATION ON EQUIPT.	CHARGED TO SPECIAL MAINT. FUND	CHARGED TO GENERAL MAINT. FUND	CHARGED TO STATE ROAD BRIDGE FUND	TOTAL COST
	SAND	BITUMEN F.O.B.	COAL	GAS FOR HEATING	HARDWARE			SKILLED	COMMON	STORAGE	TEAMING	FREIGHT	GAS, OIL & REPAIRS	LABOR					
TOTAL COST																			
COST PER SQ. YARD																			

UPKEEP COST ON ROAD SIDES & DITCHES

DATE	MACAD. SH'LD'RS.				EARTH SHOULDERS				DITCHES & DRAINS				VEGETATION				CLEANING				CULVERTS				BRIDGES				CHARGED TO SPECIAL MAINT. FUND	CHARGED TO GENERAL MAINT. FUND	CHARGED TO STATE ROAD BRIDGE FUND	TOTAL COST
	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT	SKILLED LABOR	COMMON LABOR	MATERIALS	EQUIPMENT				
TOTAL COST																																
GRAND TOTAL UPKEEP COST																																

"*" Indicates Items charged to State Road and Bridge Fund; "+" Indicates Items charged to General Maintenance Fund.
Remarks: Fix Depreciation on Auto Maintenance Truck at $ 2.00 per Mile of Pavement, portable Kettles at $ 1.00 per Mile

.....*Division Engineer*

.....*Maintenance Engineer*

FIG. 3. FORM FOR COST DATA ON ILLINOIS STATE-AID ROAD MAINTENANCE

one who goes with the truck from place to place, and he hires all the help required for any particular job. If the truck crew consisted of more there would be many days in which, on account of weather conditions, they could not work. Under the present system bad weather causes but little loss of time, as there are usually a number of things that can be done by the man in charge, such as cleaning out ditches, clearing culverts, fixing up the side roads, etc.

Where a portable heating kettle (Fig. 2) is used without the truck it is necessary to depend upon the average filling cracks and joints in concrete pavements. It is evident that a well-selected bituminous material and clean coarse sand, if properly applied, meet the requirements. Mexican, Texas and California asphalts and some refined tars have been used. A proper grade of refined tar seems to give the best results, but with any of the bituminous materials it seems to be necessary and advantageous to cover all cracks and joints twice each year, once in the spring and again in the late fall.

While the small truck referred to has been very dependable and has fulfilled most of the requirements

imposed upon it in the way of upkeep on the macadam and earth shoulders, side roads, ditches, etc., it was not designed for this purpose. It is expected that in the near future a much larger truck, operated in the same manner, will be equipped to handle the upkeep on all gravel and macadam roads, macadam and earth shoulders, side roads, ditches, etc.

System of Reports of Work Done

The truck operator is required to make a daily report on a post-card form to the maintenance engineer at the headquarters office, giving the date of his arrival on the job, the amount of road covered each day, the approximate time of finishing work and other relevant remarks.

The truck operator also sends post-card reports to the division engineer to keep him advised of when the road will be completed and when the truck will arrive at the next point. This is required that the division engineer may know what progress is being made in his division and arrange to visit the respective jobs as he finds it possible.

Upon the completion of a route or section of a state-aid road, the operator or man in charge of the work makes a detailed report of all expenditures on the accompanying form, Fig. 3. This report is checked by the division engineer, if possible, and then forwarded to the headquarters office, where the maintenance engineer makes a final check on all items of expenditure. In addition to the work report, the maintenance engineer and the division engineer are each required to make a monthly statement to the chief state-highway engineer of all money received and expended on the maintenance and upkeep work during the month.

Some Cost Data of Maintenance Work

The following data have been taken from some work recently done with the portable heating kettle and the automobile truck. Only cost data in maintaining the slab, or pavement proper, are given. The upkeep costs on macadam and earth shoulders, side roads and ditches are not included.

It will be noted that the average cost of maintenance where the truck was used is about one-third less than where the portable hand kettle was used. This will be offset considerably more in favor of the truck when the cost of supervision is included and the time required for doing the work is taken into consideration. The division engineer must necessarily give considerable of his time to maintenance work where the portable hand kettle is used. However, he has the opportunity to select good weather for all work done with the outfit and accordingly does not have any men charged against maintenance work when they are not able to work on the roads, as has been the case with the truck outfit.

It will be noted from the table that the cost of filling cracks and joints ranges from 0.1 to 0.57c. per sq.yd. of pavement, usually varying in proportion to the discontinuity of the pavement. Discontinuity is represented by the figure found by dividing the total length of all cracks and joints, in feet, by the square yards of pavement. The expression of discontinuity is figured for each road on which work is done, as it serves as a guide to compare the cost of maintenance work. It also gives a basis for comparing the condition of surfaces on various pavements.

The specifications under which the state-aid roads were constructed required a ¼-in. felt joint to be placed at an angle of 75 deg. with the center line of the pavement and at intervals of 100 ft.; joints were also required at the close of each day's work, but in no case were they to be spaced less than 40 ft. unless specified by the engineer. The 10- and 18-ft. pavements constructed under these specifications have, under normal conditions, a discontinuity of from 0.09 to 0.1.

If joints had been placed at 50-ft. intervals instead of 100-ft., the discontinuity of the surface on the normal 10- and 18-ft. pavements would have been from 0.18 to 0.2. From a maintenance standpoint, therefore, it would be an advantage to have as few joints as possible. Four years' experience in maintaining concrete pavements in Illinois indicates that joints, even though protected with armor plates, require about the same attention as do the ordinary cracks.

Definitions of the Terms Used

It is evident that the term "maintenance" has been greatly misused, or at least used to express two or three

COST DATA SHOWING THE RELATIVE EFFICIENCY OF DIFFERENT METHODS OF MAINTAINING CONCRETE PAVEMENTS BY FILLING CRACKS AND JOINTS WITH BITUMINOUS MATERIAL

			Conditions				Cost of Labor			Materials							
County	Section	Built	Width	sq.yd. (a)	Total Length in ft. of Cracks and Joints (b)	Expression of Discontinuity of Pavement, b/a	Skilled	Common	Teams, Freight, Storage, Transportation	Bituminous Material	Sand and Stone	Dep. on Equipment[1]	Supervision[2]	Total Cost	Cost per sq.yd.	Per Mile 10-ft. Road	Per Mile 18-ft. Road
Portable Heating Kettle Used																	
Cass	A	1914	10	7,279	917	0.126	$11.00	$3.50	$9.96	$1.92	$0.60	$1.25	....	$28.23	$0.0039	$22.80	
Iroquois	A	1914	10	13,433	1753	0.130	3.90	4.80	8.85	5.17	.40	2.30	....	25.42	.0019	11.70	
Iroquois	B	1914	10	14,784	1980	0.134	3.30	4.40	10.60	4.63	.42	2.60	....	25.95	.0017	10.00	
Sangamon		1912	18	12,600	6065	0.472	10.00	17.67	11.25	20.87	2.00	1.21	....	63.00	.0050		$52.80
Sangamon	B	1914	18	4,400	854	0.194	5.00	7.30	8.75	3.75	.00	0.40	....	25.20	.0057		60.20
Sangamon	C	1914	18	4,400	577	0.131	3.00	1.22	1.25	1.87	.20	.40	....	7.94	.0018		19.00
Sangamon	D	1914	18	4,000	774	0.193	3.00	1.22	1.25	1.87	.20	.40	....	7.94	.0020		21.10
Sangamon	E	1914	18	4,700	690	0.147	5.00	4.12	3.75	1.87	.30	.45	....	15.49	.0033		34.80
Menard	A	1914	10	2,667	290	0.108	3.85	0.70	3.61	1.25	.25	.45	....	10.11	.0038	22.20	
Average cost per square yard															$0.0032		
Auto Truck Used																	
Cook	D	1914	18	32,470	3120	0.096	$13.00	$8.00	$3.35	$9.69	$0.00	$6.00	....	$40.04	$0.0012		$12.65
Lincoln	A	1914	10	4,000	458	0.115	3.00	2.00	.56	1.74	.10	1.40	....	8.80	.0022	$12.90	
Lincoln	D	1914	10	4,000	503	0.126	3.00	2.00	.70	2.17	.10	1.40	....	9.37	.0034	19.90	
Livingston	A	1914	10	13,810	2240	0.162	12.00	3.75	2.80	5.57	.50	4.70	....	29.32	.0021	12.30	
Kankakee	A	1914	10	10,500	1711	0.163	14.00	4.00	1.30	5.30	1.00	3.60	....	29.20	.0028	16.40	
Will	A	1914	10	10,666	2000	0.188	18.00	4.60	4.89	4.62	.20	3.60	....	35.91	.0034	19.90	
Cook	E	1914	18	38,884	5488	0.141	21.00	8.00	4.54	8.92	.40	7.40	....	50.86	.0013		13.70
Cook	B	1914	18	14,222	1821	0.128	4.50	3.00	1.26	5.72	.10	2.75	....	17.33	.0012		12.70
Cook	A	1914	18	5,246	706	0.135	1.50	1.00	.57	1.11	.00	1.00	....	5.18	.0013		10.50
Average cost per square yard															$0.0021		

1. Under depreciation $1 per mile of pavement maintained is charged against the portable heating kettle equipment and $2 per mile for the truck. 2. The cost of supervision is prorated against the maintenance and upkeep at the close of the season.

widely different things connected with the taking care of roads. Some have divided the term, using "strict maintenance," "partial maintenance," "total maintenance," etc.

It would seem proper to confine "maintenance" to taking care of the wearing surface of the road and to use it in connection with those operations necessary to keep the traveled way true to its original type, and to use the term "upkeep" in the broader sense and to connect it with those operations necessary to keep or restore the entire road to its original surface. The upkeep should apply particularly to the sideroads, ditches, etc. The term "repairs" should be used to denote all operations necessary to restore the traveled portion of the public highway to its original condition.

Low-Lift Screw Pumps Installed at Terrebonne, La.

Two large screw pumps, one of which is shown in the accompanying views, have recently been installed in Subdistrict No. 1, Upper Terrebonne, La. These have a capacity of 45,000 gal. per min. (100 sec.-ft., or 65 million gallons per day) against a 4-ft. head. They are used for draining 4240 acres of marsh land, lifting the discharge against a total head varying from 4 to 6 ft. In general outline the pumps resemble the larger screw pumps of the New Orleans city drainage works (322 million gallons capacity against 12 ft. head) described in *Engineering News*, Jan. 15, 1914. The design, briefly described, consists of a siphon-elbow section in which a screw impeller rotates. Special effort was given in the designing and construction to reduction of flow friction.

The most interesting features of this particular type are: The conical inner case with cylindrical extensions, which surrounds the impeller shaft and which, with the outside case, forms a carefully shaped flow passage to and from the impeller; the stationary vanes guiding the water as it leaves the impeller and furnishing middle supports for the inner case; the impeller with a cast-iron center and cast-in cast-steel blades; the separate support bearings, stuffing-boxes and roller thrust bearing. Each impeller is driven by a single-cylinder 60-hp. oil engine at 200 r.p.m. This is a high speed compared with that for a centrifugal pump for such service. An efficiency of above 70% is expected over a wide range (based on actual performance of a similar 30-in. pump in New Orleans regularly pumping 24 sec.-ft. against 7 ft. head).

These pumps were designed by A. B. Wood, Mechanical Engineer of the New Orleans Sewage and Water Board, and were built by the D'Olier Centrifugal Pump & Machine Co., of Philadelphia. The driving engines were built by Fairbanks, Morse & Co., of Chicago. The J. A. Kruse Co., of New Orleans, were engineers for the plant.

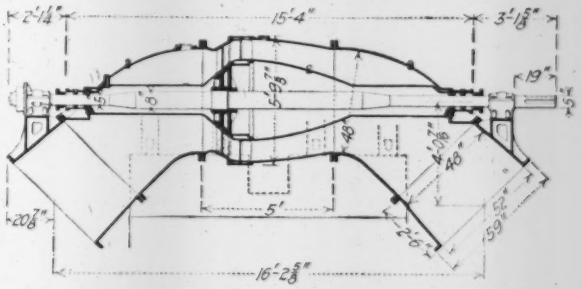


FIG. 2. SECTION THROUGH TERREBONNE PUMP

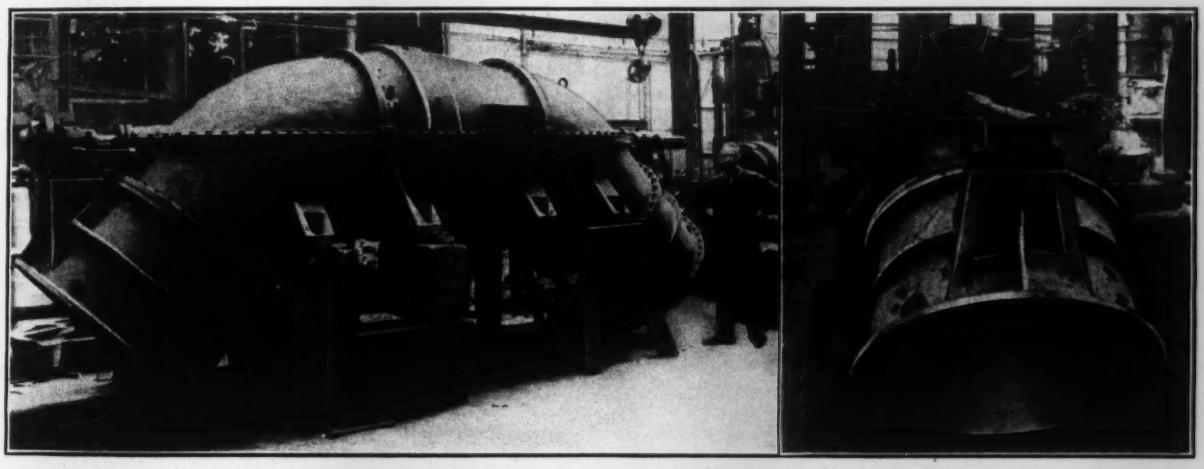


FIG. 1. HIGH-EFFICIENCY SCREW PUMP FOR TERREBONNE, LA.

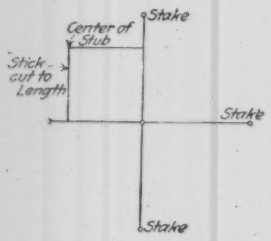
Unemployment in the Winter Season and what can be done by engineers to reduce it in amount has been investigated by a special committee of the Oregon Society of Engineers, made up of J. P. Newell, E. G. Hopson and others. The committee in its report showed that in the mild winter climate of the north Pacific coast a large proportion of engineering operations could be conducted as economically in the winter as in the summer, and that habits and custom have as much to do with the slackening of engineering work in the winter as the inclemency of the season. It is a fallacy to conclude that winter work is more costly than summer work, because on the face of the figures the cost per cubic yard of dirt handled is a little higher in winter than in summer. The economic loss to the community from having a large number of workingmen idle during the winter season must be taken into account. During the crop-season there is always plenty of demand for labor on the farms, and those in charge of public work should therefore attempt to do as much work as possible in the winter rather than in the summer. The committee enumerates various pieces of contract work performed during the winter in Portland and vicinity, such as building erection, park construction, grading, street and sewer work and highway construction, and shows that the advantage to contractors of holding their organization together and the ability to secure a better class of labor during the slack season operates to make such work, on the whole, quite as economical for the taxpayer as that done during the summer season. The commission suggested the appointment by the Governor of a commission of engineers to supervise all state engineering operations in the interest of winter employment.

Field and Office

Laying Out Tower Foundations Without Template

J. A. Walls in a paper on "Tower Foundations," in the June *Proceedings* of the American Institute of Electrical Engineers, gives the following method of laying out transmission-tower foundations:

The engineer stakes the center of the tower and marks the tower height on the reference stake; in addition to this two stakes are put down in the direction of the line and two stakes across the line. These four stakes give the center line of the base. A cord is strung across two of the stakes and the distance from the center stake to a line through the center of two holes on the same side is measured by means of a stick cut to length. The point is marked with a pin, and the operation is repeated on the other side of the center. By swinging the cord 90 deg. to the other stakes two more points are located. By laying out two sticks of a length equal to half the base width of the tower from two adjacent points found in the first operation, and then swinging them till their ends meet, the center of one corner is located. The operation is best understood from the accompanying sketch.



LAYING OUT FOOTING WITHOUT TEMPLATE

In this way two men can lay out the base in less than five minutes, and no heavy tools are required. One man is provided for each hole, and the foreman is able to take care of from three to four gangs. This method avoids the transportation of a template. When a man starts to dig a hole he first makes a circle, approximately 16 in. in diameter, around the stake and keeps inside this circle.

Repairing Asphalt Pavements Without a Plant*

By F. N. Bingham†

During the winter months, when asphalt paving plants are closed down, there are often many cuts made in asphalt pavements from various causes. These are not large at the time they are made, but if they are allowed to remain unrepaired for weeks or sometimes months, the abrasion of traffic will cause raveling and disintegration to take place, and the cut to be repaired will be much larger than it was originally. The postponing of repairs to warm weather thus leads to disputes between the city and the person who made and has to pay for repairing the pavement cuts. Not only do these cuts ravel and disintegrate if left unrepaired, but with the coming of spring thaws and rains the water invariably gets under the pavement for a considerable distance and causes the destruction of correspondingly large areas of pavement.

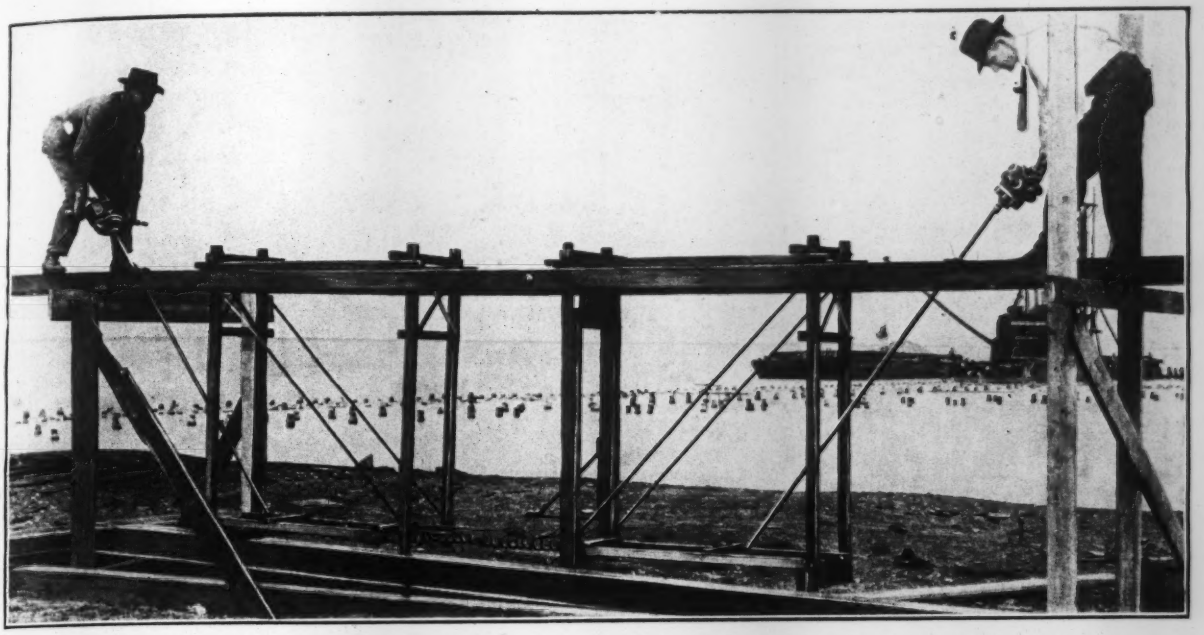
It is not feasible to start up an asphalt plant to turn out such a small quantity of material as is usually needed to fix a few winter cuts. In order to take care of these repairs as needed when our Spokane municipal plant is closed down, we have found it very economical and practical to proceed as follows:

Before the plant is closed down for the winter we make up a hot mixture of sand, filler, stone and asphaltic cement, as though it was for immediate use, the only difference being that we use a mixture richer in asphaltic cement than is usual. This mixture is then lightly spread by means of rakes to a uniform depth of 3 in. on a smooth plot of ground that has been lightly sanded and, while

*For further information on this subject the reader is referred to "Engineering News," Feb. 11, 1915, p. 258, an article on "Patching Bituminous Pavements Without an Asphalt Plant or a Steam Roller," by Samuel H. Lea, City Engineer, Charlotte, N. C.

†Superintendent of the Municipal Asphalt Plant, Spokane, Wash.

OUTFIT FOR REPAIRING ASPHALT PAVEMENTS IN SPOKANE, WASH., DURING THE WINTER MONTHS



MACHINE FOR BORING TIE-ROD HOLES IN PILES UNDER WATER, CHICAGO MUNICIPAL RY.
In service, the sills on which the men are standing rest on the pile heads

still hot, is marked off into cakes approximately 2 ft. square, care being taken not to pack or compress this hot mixture in any way while it is cooling. When cool the asphalt layer is easily broken up into cakes and is ready for use.

Our emergency-repair equipment consists of a small motor truck with a sheet-iron heating pan with gasoline burners. These burners are so placed that they are not only used to heat the contents of the pan, but to heat the tamping and smoothing irons as well. The truck is then loaded with the asphalt cakes, which are carried to the cuts to be repaired. While the cut is being prepared, the asphalt cakes are heated in the pan and brought to their original plastic consistency. The cut is filled, tamped, smoothed and finished in the usual manner. The truck driver and two men make a crew, and the cost of this work is surprisingly low per square yard.

The value of the results obtained in keeping holes and cuts promptly repaired is obvious. Such repairs can be made in freezing weather, even when it is necessary to sweep away snow to get at the pavement. Oftentimes when a small gas- or water-pipe cut is partly filled with ice, the big warming pan is placed directly over the cut while the asphalt cake is being heated, and the cut is dried out at the same time and with the same heat. This method can be used to equal advantage in small towns or on highways, where permanent asphalt-mixing plants are not always available.

Machine for Boring Under-Water Holes in Piles

The new 3000-ft. Municipal Pier at Chicago has on each side a concrete wall supported on three lines of round piles and a line of sheet piling. Tie-rods extend between the rows of piles, and in the outer part of the pier there are heavy tie-rods extending across the entire width of the pier, to tie the walls together. The boring of these numerous tie-rod holes under water, and keeping them in proper line and level in the piles and sheet-piling, would have been a tedious and troublesome job. Therefore a special machine, shown in the accompanying view, was devised and built by the contractor, the Great Lakes Dredge & Dock Co., of Chicago.

The machine consists of a pair of sills 30 ft. long, with two depending frames, which slide along them and carry horizontal guides for the augers. The end of each auger rod is connected by a universal joint to a long rod driven by a pneumatic drill held by a man on top of the frame, as shown. The sills rested on the pile heads and the auger guides were set at the desired height and position. With the holes bored in this way there was no difficulty in placing the tie-rods.

Concreting Trains for Track-Elevation Work

For building the concrete retaining walls and bridge abutments on the Chicago track elevation of the New York, Chicago & St. Louis R.R. an outfit of concreting trains has been used by the Brownell Improvement Co., of Chicago, which has the contract for the work. One of these trains is shown in Fig. 1; the towers of two other trains may be seen in the distance.

The special features of the arrangement are that the train is a complete unit of material cars and mixing plant and that all material is handled directly upon the train. This latter point is important when the train is located beside (or sometimes between) main tracks and there is practically no space available outside of the construction train. The mixer car is at the head of the train, then come two cars of broken stone, two cars of screenings and a boxcar for cement (in sacks).

Planks laid across the open cars carry two runways, each two planks wide. If the load is piled up so that the cross-timbers cannot be placed, brackets are fitted

FIG. 1. CONCRETING TRAIN FOR BUILDING ABUTMENTS AND RETAINING WALLS ON TRACK ELEVATION WORK AT CHICAGO; NEW YORK, CHICAGO & ST. LOUIS R.R.

The towers of two similar trains on the same work can be seen in the background

on the side of the car, carrying the runway planks at the proper elevation. Similar brackets are fitted on the sides of the boxcar. The cement, stone and screenings are loaded into wheelbarrows and wheeled to the mixer, the empties returning on the same runway.

When the material cars are empty the planks and brackets are thrown off and the cars are hauled away, while another set of five loaded cars is run up to the mixer car. The runways are quickly set in position and work is resumed. It takes only from 15 to 25 min. to switch the cars and get the work started again.

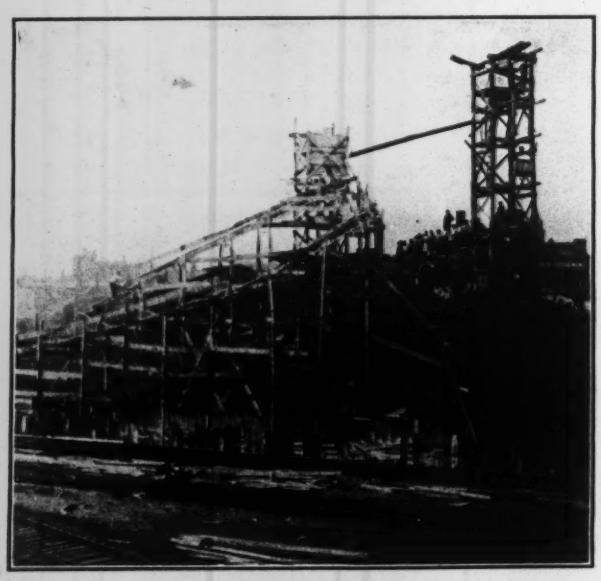


FIG. 2. SPOUTING CONCRETE ACROSS MAIN-LINE RAILWAY TRACKS

Pennsylvania Lines. Track elevation work at South Chicago, Ill. The taller tower, with elevator bucket, is on the front car of the concreting train. The steel chute carries the concrete across the two main tracks to the stationary tower, from which several lines of chutes extend to the forms.

The mixer plant consists of a special boxcar, with a 1-yd. drum mixer mounted at the forward end. Behind this are the engine and boiler, while the sloping roof forms the wheeling platform, with a charging chute to the mixer. Directly over the mixer is a tower 8 ft. square, and about 55 ft. high above the rails. In this is mounted the receiving hopper of the distributing spout. The elevator bucket travels on leads placed not in the tower but ahead of it, far enough from the front face of the tower to enable the bucket to clear the end sill and drop below the level of the car floor to receive the concrete from the mixer.

The bucket is narrow and deep, and, at the upper end of its travel, rollers on the top engage inclined guide rails so that the bucket is pulled over, tilting to such an angle as to insure complete discharge of the material. The two jointed sections of the steel spout, each about 28 ft. long, are guyed from a 31-ft. boom stepped on the tower. Fig. 1 shows a third spout laid longitudinally along the forms and delivering the concrete in place.

With this arrangement the concrete can be spouted across running tracks. This was done on the South Chicago track-elevation work of the Pennsylvania lines, where the two main tracks extended between the concreting train and the retaining walls. There was no trouble from the spattering of concrete upon the trains. This South Chicago work is shown in Fig. 2.

In the view Fig. 1 the tower is guyed to a building. This was done because the train stood on a rough temporary track. Ordinarily no such support is needed. The tower is not built in removable sections, but that part extending above the roof of the car must be dismantled when bridges are to be passed or the outfit is to be shifted. The machinery is selected to suit the contractors' ideas as to the best combination, and on the outfits shown herewith it includes a Foote concrete mixer, Archer elevator bucket and steel spouting, and a Clyde hoist and engine. For the temporary trestle of the south ap-

proach to the elevation of the New York, Chicago & St. Louis R.R., the piles were driven by a McMyler 35-ton piledriver running on a track parallel to the trestle. This machine has a revolving horizontal truss, the outer end of which carries the 53-ft. leads.

This arrangement of concreting trains has been used by the Brownell Improvement Co. on nearly all its numerous contracts for track-elevation work in Chicago. The work was in charge of A. H. Bannister, General Superintendent of the company. With three of these trains on the New York, Chicago & St. Louis R.R. work shown in Fig. 1 about 27,000 cu.yd. of concrete were placed in 62 working days.

Portable Track Crossings in a Contractor's Yard

Portable track crossings in a construction track layout are in use at the temporary storage yard of Walter H. Gahagan, Inc., contracting engineer, at East New York, Borough of Brooklyn, New York City. A narrow-gage construction track turns out of a standard-gage track, a third rail being laid in the spur. A stub switch in one rail provides the connection.

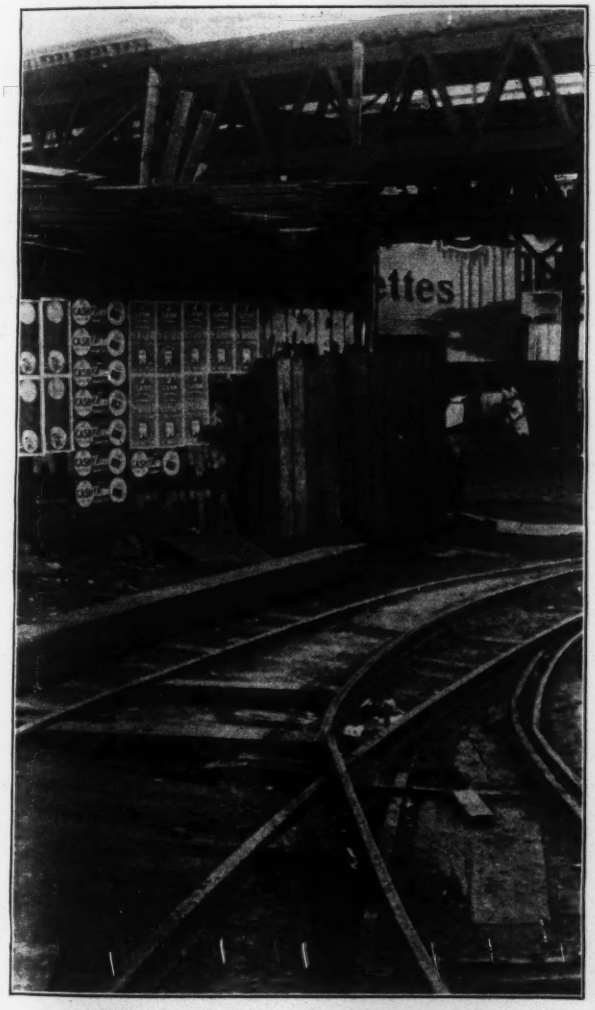


FIG. 1. MOVABLE RAIL IN PLACE OF FROG

FIG. 2. ANGLE IRONS FOR RAILS OF NARROW-GAGE TRACK AT CROSSING

To avoid the cost of a special frog, a frogless crossing was designed. The outer rail of the narrow-gage turnout is raised to cross over one rail of the standard-gage track. This crossing rail can be swung off the standard-gage rail by hand, to allow cars to move on the latter track. When the swinging-rail is in place to allow standard-gage movement, it is braced by a bar placed between it and the opposite narrow-gage rail. This arrangement, shown in Fig. 1, is a simplification of the frogless turnout used to a limited extent in main-track service.

At the other end of the yard, where the narrow-gage track crosses several standard-gage tracks, angle irons supported by timbers are used instead of rails for the narrow-gage track. This does away with the necessity of blocking up the small narrow-gage rails to the height of the standard-gage rails. The arrangement is shown in Fig. 2.

Water-Works Transportation Methods were made the subject of thorough study in Chicago, Ill., in 1914. A transportation section was organized in the division of water-supply extension with a head motor-truck driver in charge. One 5-ton and three 2-ton Pierce-Arrow trucks were used in the experiments. The cost of hauling averaged about 13c. per ton mi. for the 5-ton truck and varied from 14c. to 32c. per ton mi. for the 2-ton trucks, depending on the conditions and efficiency with which they were used. The hauling under contract by teams cost on an average 26.9c. per ton mi. The hauling by teams hired by the day was still higher. The recent annual report of the city engineer for the year 1914 states that the use of motor trucks and the general study of transportation have shown that the motor trucks are economical and efficient when properly handled, that the hauling of certain materials by contract is advisable, and that teams hired by the day are not efficient.

Comparative Costs of Laying 16- and 12-Ft. Pipe

The introduction of 16-ft. lengths of cast-iron pipe for city water mains was noted in *Engineering News*, May 6, 1915, in an editorial on "Longer Cast-Iron Pipe." Although answers to inquiries concerning experience with the new 16-ft. pipe lengths showed general satisfaction, few of the cities which have introduced the longer pipe have kept sufficient cost records to enable an exact comparison to be made of the merits of the new 16-ft. lengths and the old 12-ft. lengths.

Since then, S. L. Etnyre, superintendent of the waterworks department of Council Bluffs, Iowa, has sent the accompanying table of three very similar jobs of pipe laying, in April, 1915, the first example being a 6-in. main in 16-ft. pipe lengths, while the second and third examples are 6-in. mains in 12-ft. pipe lengths. All these mains were laid with 5 to 5½-ft. cover, and careful records were kept to make an accurate comparison of costs.

Floating Concreting Plant with Mixer in Tower

A large floating concreting plant of unusual layout, in which the cement, sand, gravel and water are dumped into a bucket and hoisted up in the tower to a Hains mixer, is being used in concrete-pier construction for the Lehigh Valley R.R. at Pier 8, North River, New York City. The mixer is installed about two-thirds of the way up the 55-ft. tower, the bucket containing the unmixed materials being hoisted by a two-drum Lambert hoisting engine. The apparatus is mounted on an old car float, 310x36 ft. in plan, which was purchased for the purpose by the Henry Steers Contracting Co., 17 Battery Pl., New York City.

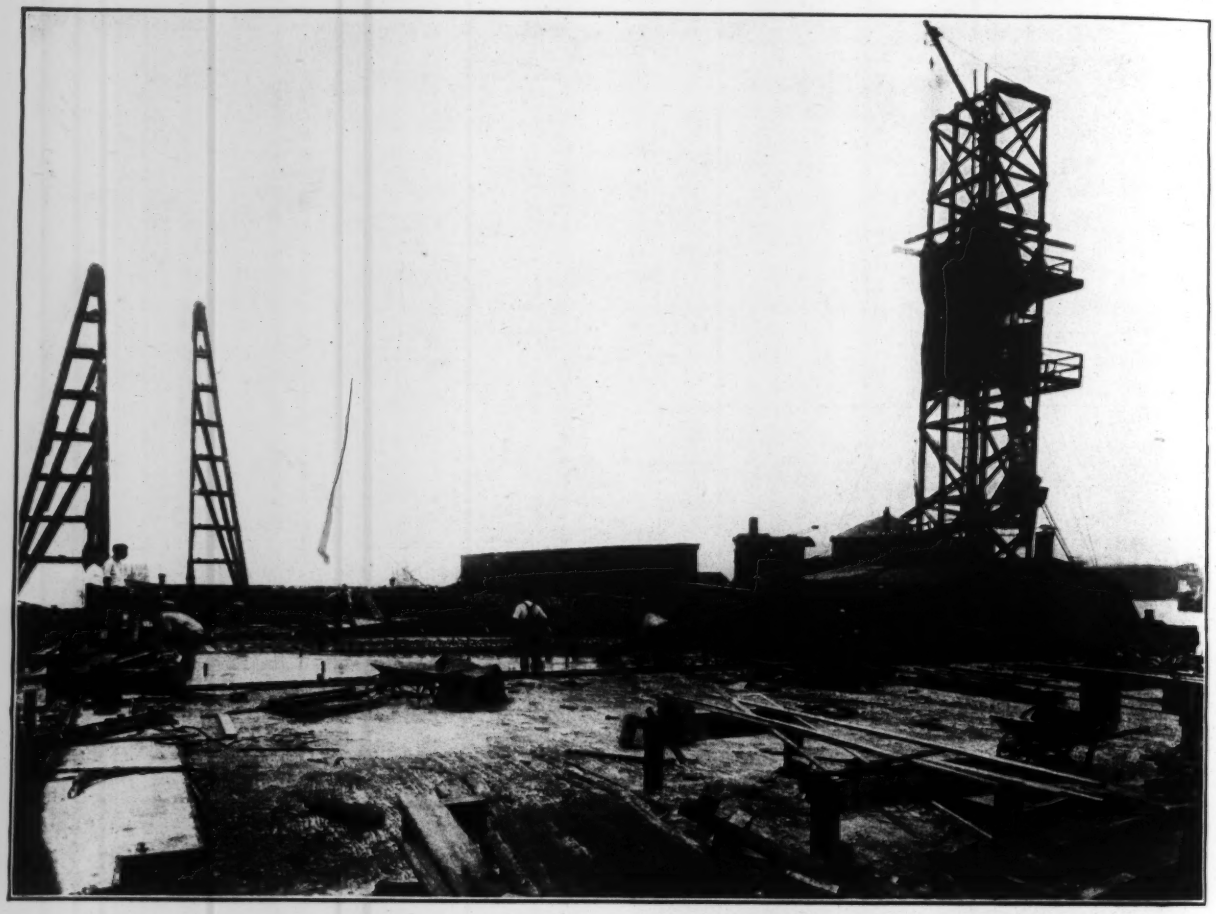


FIG. 1. GENERAL VIEW OF PIER AND PLANT

Chute is lower than in Fig. 2, owing to concreting being nearer the floating plant.

The sand and gravel arrive already mixed, this having been done at the contractor's pit on Long Island. The handling at the site is thus simplified, one scow only being necessary where otherwise two would have been required. The sand and gravel are handled from the

COMPARATIVE COSTS OF LAYING 16- AND 12-FT. LENGTHS OF 6-IN. CAST-IRON PIPE

				——6-In. C.I. Main on Ground——					Ex. and B.F.		——Pipe Laying Costs——							
No.	Street	From	To	No. of Lengths	No. of Ft.	Wgt. in Lb.	Price per Ton	Amt.	Price per Ft., Cts.	Amt.	Cost at 20c. per Hr. Bell Holes at 25c. per Hr.	Caulking at 25c. per Hr.	Lead at 4c. per Lb.	Laying, Jute, Fuel, Etc.	Total Cost	Cost per 1000 Ft.	Average Cost per 1000 Ft.	Diff. in Cost per 1000 Ft.
1.	High St.	10th Ave.	15th Ave.	103	1648	57,470	$23.95	$688.20	16¼	$269.09	$14.78	$11.02	$38.54	$44.37	$1066.00	$646.85	$646.85	
2.	Fairmount Ave.	Graham.	Fairmount Park	97	1164	42,104	22.95	483.14	16¼	189.18	13.49	10.03	38.41	30.65	764.90	657.13	$866.93	$20.08
3.	15th Ave.	High St.	Fairmount Ave.	94	1128	42,341	22.95	485.86	15	175.80	15.09	9.90	40.00	36.70	763.35	676.73		

deck-scow by a 60-ton locomotive crane, equipped with a 1-yd. bucket, running on a track laid on the mixing float. The crane delivers the material to a 20-yd. hopper, located at one end of the float, in the lower portion of the tower. The cement arrives on covered barges and is unloaded onto a belt conveyor which runs the length of the float. This conveyor runs through a long cement-storage shed (shown at the left in Fig. 1) which has a capacity of 1500 bbl. of cement. When concreting is in progress the cement bags are laid on the conveyor as required, and thus moved to the tower-end of the float. Here the cement is dumped into a 1-yd. bucket, in which also is placed sand and gravel from the hopper, and water for the batch.

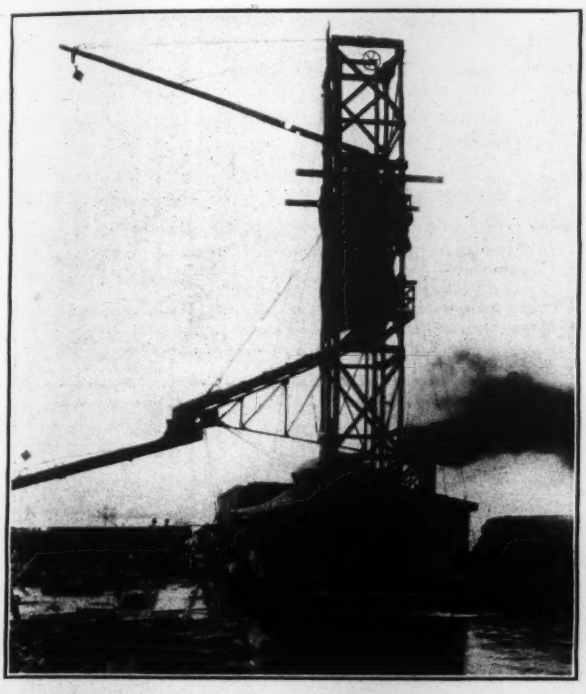


FIG. 2. CONCRETING PLANT, WITH SAND AND GRAVEL SCOW AT RIGHT AND NEW PIER AT LEFT
Note method of supporting first chute, in its highest position

The bucket is then elevated in the tower to the mixer, the lower hopper of which is at an elevation of about 30 ft. above deck. When the unmixed materials have been dumped into the top hopper of the mixer, the gate in the bottom of this hopper is opened, allowing the mix to drop into the second hopper, thence by a similar procedure into the bottom hopper, which discharges into the chuting system. A water pipe runs up the tower, so that the mixer man can add more water if required.

The chuting system is swiveled in such a way that the chutes can be swung about easily. Approximately two-thirds of the width of the pier can be reached by the main chute and extension which are supported by a boom on the tower. To concrete the farther side of the pier, extension-chutes supported on bents are placed. The chutes are raised and lowered by steam power, the cable for this purpose running to the hoisting engine. They are swung sideways, either by hand-tackle or by lines run to a winch-head on the engine.

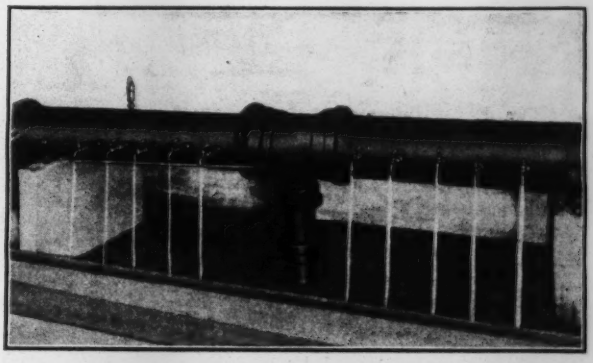
J. Y. Higginson, Superintendent for the contractor, states that about 40 yd. of concrete can be laid per hour on this class of work by this plant.

The Lehigh Valley R.R. pier is of a design not at all familar to New York City. The concrete legs rest on a pile substructure cut off at about mean water line. The bents are spaced 10 ft. c. to c., and the bent piling 3 ft. 8 in. c. to c. crosswise. The piles in each bent are clamped at the top instead of being capped, and the spaces between the piles form a key to hold the foot of the concrete leg in position; also, rods driven in the head of the piles extend up into the concrete, and the bents are braced longitudinally by three lines of concrete diaphragms, and in addition timber bracing is provided at the sides of the pier. There is a continuous heavy fendering on each side of the pier from m. l. w.

The pier was designed and is being constructed under the supervision of E. B. Ashby, Chief Engineer of the railroad; J. J. McCleece, architect, was in charge of the designing.

NOTES

Demonstrating the Cost of Water Waste to private consumers has become a valuable aid to many city water-works departments in reducing useless water consumption and conserving water supplies. In St. Louis, Mo., in order to obtain an idea of the amount of water which may be wasted through a faucet at a pressure representative of the average pressure throughout the city, the device shown in the accompanying illustration has been prepared. Ten faucets of the type ordinarily used for domestic purposes are so arranged that



DEVICE OF THE ST. LOUIS, MO., WATER-WORKS DEPARTMENT FOR SHOWING WASTE FROM SMALL LEAKS

the streams vary from $\frac{5}{8}$ in. in diameter at the right down to $\frac{1}{32}$ in. in diameter at the left. The size of each individual stream, the rate of flow in gallons per minute and the cost of the water per 24 hr. are shown in the table. The smaller of these streams represents a small, ordinary leak, while the larger ones represent a condition where there is a careless or willful waste of water due to allowing faucets to remain open when not in use. The accumulative waste and loss in dollars and cents may be readily figured when it is remembered that there are several hundred thousand faucets in use in the city daily.

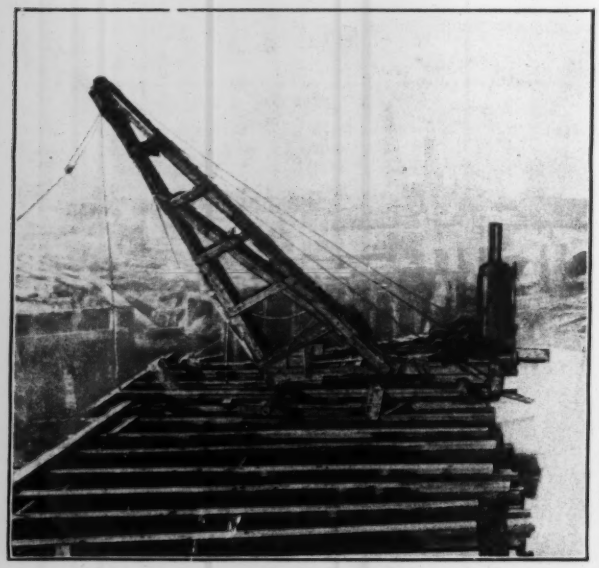
Size of Stream Through Faucets	Rate of Flow, Gal. per Min.	Cost of Water Flowing Continuously for 24 Hr. at 9 c. per 1000 Gal.
$\frac{5}{8}$ in.	4.86	$0.630
$\frac{1}{2}$ in.	4.16	.540
$\frac{7}{16}$ in.	3.24	.420
$\frac{3}{8}$ in.	1.90	.247
$\frac{5}{16}$ in.	1.50	.195
$\frac{1}{4}$ in.	1.29	.167
$\frac{3}{16}$ in.	1.10	.142
$\frac{1}{8}$ in.	.86	.112
$\frac{1}{16}$ in.	.44	.057
$\frac{1}{32}$ in.	.13	.017

A somewhat similar idea is employed in several city-budget exhibits. A glass-encased water meter, with a thin stream of water continually flowing through, is displayed. Here, the householder can actually see how small a leak is sufficient to make the wheels go round; and a prominently posted notice

informs him what the water is costing per day, per month and per year. This is said to be a very effective means of bringing home to the negligent consumer the advantage of good plumbing.

Concrete Field-Test Beams are used to control the concreting operations in the land spans of the Detroit-Superior viaduct, Cleveland. When concrete is being poured the engineers of the county field office take samples as it goes into the forms, and pour unreinforced test beams 4x6 in. by 3 ft. These are allowed to set in the field and at the age of 14 days are tested by center load on a 30-in. span. The aim is to secure a modulus of rupture of 300 lb. per sq.in., which corresponds to a center load of 960 lb. (or for depth of test beam 5¾ in., which is usually the actual depth, the load would be 880 lb.). The tests made have given failure loads of 800 to 1200 lb., and the lowest test so far obtained was 760 lb. K. D. Cowen is resident engineer in charge of the field office.

Batter Piles Were Driven at the new Southwark Piers on the Delaware River at Philadelphia with the piledriver shown in the accompanying view. This machine consists of normal piledriver leads fixed at the required angle by an extension frame at the bottom. This frame was then fastened to a base



PILEDRIVER RIGGED TO DRIVE BATTER PILES

frame on which the engine rested and which was moved where required on rollers underneath. The drophammer moved in guides which kept it from swinging out beyond the leads. The work is being done by the Snare & Triest Co. under the direction of John Meigs, Director of the Department of Wharves, Docks and Ferries.

Filling an Old Tunnel by Hydraulic Sluicing is an interesting piece of work in progress at Tacoma, Wash. The tunnel was started about six years ago as an entrance for the Union Pacific Ry. into Tacoma, but was abandoned when a trackage agreement was made with the Northern Pacific R.R. The tunnel was for a single track and on a grade of 1.5%. The work was done by Twohy Bros., of Spokane; but the tunnel was excavated for only about 2600 ft., and none of this was concreted. As the route was under city streets and improved property, the continual caving and settling due to the decay of timbers was a menace to the community, and the City Council ordered the tunnel filled. The contract was let to Stillwell Bros., of Seattle, who are now doing the work. Their method consists of sluicing earth from a hill about 1800 ft. from the upper end of the tunnel. The earth is carried in a closed pipe on a steep grade into the tunnel and water escapes at the lower end. It is said to be too early to state whether this method will insure a solid fill for the entire area. It is not practical to blow off the roof and fill from above on account of the streets and improvements immediately overhead. Various shafts have been sunk at points between the ends, and this will aid somewhat in the filling operations. For information we are indebted to W. C. Raleigh, city engineer of Tacoma.

The Traffic-Control Signal shown in the accompanying view has been found useful in Pittsburgh. It is commended by the director of safety and the superintendent of the Pittsburgh Railways Co. The diagram shows the installation at Smithfield St. and Sixth Ave. The signals are simple lamps made of No. 22-gage iron and fitted with 10½-in. colored lenses, tilted 10 deg. down from the vertical. Sixty-watt lamps give a distinctive indication, though in locations where the sun could shine directly on the lens small hoods might be needed. The lamps are operated by a four-way circuit controller. This has an auxiliary latched handle by which all the red lights can be shown at once or red on one street and green

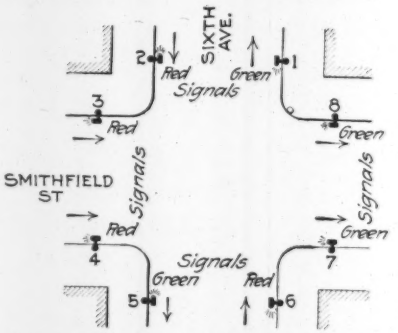


FIG. 1. TRAFFIC SIGNALS AT A PITTSBURGH CORNER

on the other, or all can be extinguished. This facilitates holding up traffic as needed for passing fire teams and ambulances.

Heavy Viaduct Railing is to be placed on the steel highway viaduct now being built by the city of Cleveland, Ohio, across the Cuyahoga River valley on the line of Clark Ave. The railing is 4 ft. high. Its main members are 4-in. I-beam posts

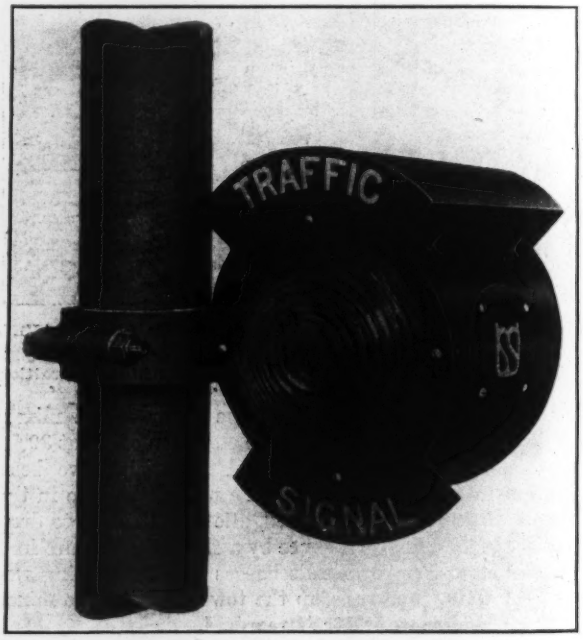


FIG. 2. PITTSBURGH TRAFFIC SIGNAL

spaced 16 ft. apart, 3-in. channel bottom and middle rails, and a top rail of 3-in. steel pipe seated in a 2½-in. channel. The filling is vertical ¾-in. square rods, set 4¾ in. apart, passing through the webs of the channels, riveted over on top and held in the other rails by special locking clips. It is built by the Van Dorn Iron Works. H. Brockelbank worked out the design of the structure under the direction of F. D. Richards, city bridge engineer.

Marketed Production of Chromic Iron Ore increased in 1914, according to J. S. Diller, of the United States Geological Survey. The output sold was 591 long tons, valued at $8715, as against 255 tons in 1913. Almost all of it came from Shasta County, California. The largest producers of chromic iron ore are New Caledonia, Rhodesia and Russia.

Editorials

Lesson of the Erie Flood

The Erie flood gives a knockout blow to a principle which has been put forward many times—that it does not pay to provide waterway for the very largest storms; that it is cheaper to let culverts wash out once in fifteen years or so. Ask any one of the thousands of Erie citizens affected by the flood whether it would not have been economy to provide a more capacious channel, and he will answer promptly. He can see very clearly in the light of his present troubles that the principle mentioned means nothing more or less than that the builder wants to shift the burden of risk carelessly upon a future generation.

The principle is one which railway engineers have used in their work, and this in regions where a washout of the culvert would affect no one but the railway itself. There is no evidence that any engineer ever applied it to culverts or bridges in a city or village, where destruction other than the mere wrecking of the culvert would be likely. But the very existence of such a theory of alleged economy tends to influence practice in fields where it was never intended to apply. Who will say that a fashion of "close" proportioning of waterways existing, say, among the railway engineers of the eighties would not find unconscious followers among municipal engineers? The latter did not have long-time records of rainfall to tell them what would be the probable maximum storm. They had only the physical evidences furnished by the valley topography itself, and this was practically never regarded, as was brought out so strikingly by the 1913 flood in Ohio and Indiana.

But why speak of engineers alone? The situation at Erie was that any private owner along the stream could do with the channel just about what he pleased, and many of them did so. The city never had authority to control the channel and never tried to get such authority. The Pennsylvania legislature, exactly like other state legislatures, left the entire subject of stream control and protection to the dark mysteries of judiciary riparian law. The legal mind in the legislature has ever preferred that matters be left in this headless shape, waiting for the teachings of experience to demonstrate the need of administrative provision. The city of Erie has just paid several million dollars and three dozen lives for a bit of such experience.

It is to be hoped that the rainfall and runoff experts will seek out and study the engineering facts of the Erie flood in such a way as to improve our knowledge. The maximum flood flow needs to be determined, and also its relation both to the physical character of the region and to the peculiar nature of the storm. In view of the fact that greater rainstorms than the one of Aug. 3 have occurred elsewhere, an estimate should be made of the maximum flood which may be expected in Mill Creek. Meanwhile it must be assumed as probable that in almost any stream area such a distribution of rainfall maxima may occur as will make the interval coincide with the runoff period of the stream and thus create a cumulative flood.

Concrete Chuting Predominant

Engineers who have had the opportunity to travel widely during the last year or two have been impressed by the almost universal use of the chuting method of placing concrete and the ingenious adaptations of that method, which only a few years ago was restricted to well-defined limitations of area and local topography. In this issue of *Engineering News* this development is emphasized by four articles describing radically different kinds of construction, in each of which the chuting system was used, though each case shows a different variation of the general principle. Thus, the four plants comprise a lake pier superstructure with a high central tower, a low retaining wall with towers traveling on railway trains, a river pier substructure with a floating tower, and a warehouse with two towers controlled from a central mixer. Any method or principle that can be adjusted to meet so many phases of a problem surely deserves success.

In this demonstrated success, so widespread that the chuting system has practically driven out of use every other method of placing concrete, it is somewhat curious that a former criticism seems now to have been forgotten. A year or more ago when the chuting system was first booming there were many and frequent complaints that its use required an excess of water in the concrete, and an excess of water was regarded as a set-retardant and a reducer of early if not of final strength. This complaint naturally enough came from the engineer or owner who had let the concreting for a fixed price and not from the contractor who was interested in the cost reductions the chuting method was bound to show. Today, while this criticism is still occasionally heard, its force must certainly have abated, else the concrete tower and chute would not be the predominant feature in most concrete jobs.

In spite of this passive resistance, if in fact there is left any resistance to the chute, there was probably much of truth in the claim that a gravity flow of concrete requires a too wet mix, unless great care is taken to insure a short radius of control or a great height of tower. It is because there seems to be no definite standard of wetness of concrete nor any very good service tests showing the relation of wetness to strength that the voices opposed to the chuting method have been reduced in volume if not in number.

Selecting the Right Occupation

Many men go through life discontented and unsuccessful because in their early years they entered an occupation for which they were unfitted. Those in charge of public and private educational work have for a dozen years past been taking increasing interest in vocational guidance, or the systematic advising of young men and women as to the sort of work in which they are most likely to succeed. A somewhat similar problem faces those in charge of the employment of help in large industrial establishments, where applicants for employment must be exam-

ined and a determination reached as to whether they are worth hiring and in what department they can do the best work.

Where an organization is built up slowly from small beginnings through a long period of years, employees are selected one by one and carefully tried out, and by a process of the survival of the fittest an efficient organization is created. These are days, however, of extremely rapid changes in industrial organizations. A good illustration is furnished by the sudden fluctuations in demand and supply brought about as a result of the war. Factories have been set going with 5000 to 15,000 employees on tracts where a year ago there was not a stone or a stick of timber.

Not from choice but from necessity the worker is obliged to shift rapidly from place to place in accordance with changing markets and conditions; and this applies not merely to the ordinary wage worker but to foremen and superintendents and managers, and the office force. It is therefore an extremely important matter to know how to select men who are capable of good work and to assign them to the class of work for which they are best fitted by ability and experience.

Under these conditions a certain class of business doctors has come forward with the claim that the task of picking the right man for the job need no longer be conducted by the cut-and-try methods hitherto used. Instead we are told that the selection of men and women for a task has now been reduced to a science and that by taking a course of correspondence instruction one can learn how to tell by the length of the fingers, the shape of the nose or chin or ears, the bumps on the skull and various other physical characteristics what sort of work the man is fitted to perform with success.

Another scheme for scientific selection is represented by leading experts in the science of psychology. These reject *in toto* the claims of the efficiency doctors just mentioned, but maintain that by a practical application of modern principles of psychology it is possible to determine by easily applied tests what sort of mental abilities a person has and thus what he or she is good for.

Certainly, if the claims made by either of these groups have a substantial foundation, their scientific plan of selecting men would be one of the most important discoveries of the present century. The success of an individual may be influenced very largely by his choice of an occupation, and the success of an organization depends very largely upon the character of the men who direct it. If, therefore, either of these systems furnishes a test by which the capabilities of men and women for particular tasks may be accurately determined, its value could hardly be overestimated.

Prof. Herman Schneider, Dean of the College of Engineering, University of Cincinnati, and well known as the originator of the famous coöperative courses at that university, has recently published a statement concerning this question that deserves general attention. In a paper entitled "The Problem of Selecting the Right Job" he relates his experiences with different methods of testing the capabilities of men. Success in the coöperative-education course is largely dependent, Professor Schneider states, on carefully selecting men who are naturally adapted to the work for which they are to be trained. He therefore determined to analyze the different methods of selecting men for the job, just as an engineer would analyze an engineering project. The plan of selecting men by their physical characteristics Professor Schneider discusses as follows:

> **A group in the scientific management field affirmed that an examination of physical characteristics, such as the shape of the fingers and shape of the head, disclosed aptitudes and abilities. This seems to be a development of the old idea of phrenology. For example, a directive money-making executive will have a certain shaped head and hand. A number of money-making executives were picked at random and their physical characteristics charted. We did not find that they conformed at all to any law. Also we found men who had the physical characteristics that ought to make them executives, but they were anything but executives. A number of tests of this kind gave negative results. We were forced to the conclusion that this system was not reliable.**

Professor Schneider turns next to the claims of certain professors of psychology. The experimental psychologist claims that certain mental qualities, such as memory, attention, observation, suggestibility, apperception, and so on, are indicative of a person's ability and adaptation to certain fields of work. Professor Schneider has tested these claims by examining the members of the graduating classes in the coöperative course at the university. These men had been in the university for five years in school work and shop work and a fair knowledge of their abilities had thus been obtained. Two of these graduating classes have been tested by the psychological method, and a third is now being tested. The records of the men's work since graduation are also being kept in order to determine whether there is any correspondence between the results obtained by the psychological test and the results shown by these men in business. Professor Schneider states that the test has not shown that the psychological method is reliable or practical.

Turning then to the old-time method of trying a man on the job, Professor Schneider concludes that this is still the only method by which the abilities of a man can be finally determined. This does not mean, however, that there is nothing which can be done by a keen and skilled observer in the selection of men otherwise than at haphazard. On the contrary, Professor Schneider enumerates a number of physical and mental characteristics which can be determined by careful examination and which do indicate to a certain degree what sort of task a man can reasonably hope to succeed in.

Of course, at the start it is evident that for an occupation requiring physical strength men of large muscular organization will be selected. It is almost as easy to determine whether a man has manual dexterity or is lacking in that quality. Again, some men naturally assume responsibility, while others shrink from it. Some men have no originality, while others are not contented with routine work but demand something new.

Professor Schneider sums up the results of his studies as follows:

> **The conclusions so far drawn from our experiences with about a thousand mature students in school work and practical work are: (1) A worker's failure is as significant as his success and should be a guide to a new and fitting job. (2) The characteristics developed by analysis of many successes and failures furnish a basis for placement which works better than any plan we know. (3) The method is crude and unscientific; it requires a period of time much greater than other methods proposed, but it insures a reliable verdict.**

Professor Schneider also sounds a warning against the abuse of the vocational guidance course already incorporated in a number of the public schools. He believes that not enough is known to warrant any man in saying to a child: "This is your job and that is not your job."

Licensing Structural Engineers in Illinois

Hitherto there has been practically free trade in the engineering profession throughout the United States. An engineer or an engineering firm in Boston or Philadelphia or Chicago or San Francisco has been free to carry on professional work anywhere in the United States. The trifling exceptions relate solely to work which is invariably done by men resident in the locality.

In a number of cities, for example, land surveys within the city boundary can only be made by city surveyors who have received licenses to perform that work. The State of Wyoming has for several years required engineers who lay out irrigation ditches to have a state certificate showing their qualifications to perform such work. In a number of states where mining is an important industry, engineers practicing mine surveying have to secure a state license.

These and similar exceptions, however, relate to work which would normally be done by men resident in the locality anyway. The structural engineers' license law just enacted in Illinois is the first interference by state legislation with general engineering work and may be said to be, therefore, the first barrier to free trade in this field in the United States.

Hereafter on every structure erected in the State of Illinois which is important enough to require the services of a structural engineer in any capacity upon its design and construction, that engineer must have a state license. To obtain such a license is not at present a difficult matter. Any resident of Illinois now practicing structural engineering may be licensed to practice without examination on payment of a fee of $50. Engineers not residents of Illinois who wish to practice structural engineering within that state must apparently be prepared to take an examination before the board, no matter how extensive their experience, according to the wording of the law.

There is indeed a clause permitting the State Board of Examiners in its discretion to issue an Illinois license without examination to structural engineers who are licensed under the laws of any other state or territory, or of any foreign country, providing such engineers have received licenses in their home state under a law as stringent as the Illinois law. As there are no states which have such laws, this clause is of no present importance.

Under this law, railway companies which have bridges or stations to construct or repair in Illinois must have the engineering work done by an engineer licensed under the state law. If the company's own bridge engineer resides in some other state, he will have to go to Illinois and take an examination or relinquish responsibility for the work to someone else. A manufacturing corporation may have plants in several different states and be accustomed to carry on repairs and enlargements from its general offices. If it wants to do any work on a plant located in Illinois, however, the engineer at the head office will need an Illinois license or will have to engage some engineer resident in Illinois to do the work.

As has been fully recorded in these columns, the Illinois law is the result of a situation forced upon the structural engineers of Illinois by the previous enactment of the Illinois architects' license law. The architectural profession has already traveled a considerable distance along the road toward the establishment of state boundaries for professional practice.

One possible result of the Illinois law may be the more general requirement of engineering skill in structural design. The language of the law is that structural engineering is necessary for structures "in which safe design and construction require that loads and stresses must be computed, and the size and strength of parts must be determined by mathematical calculations based upon scientific principles and engineering data."

This clause would seem to mean that any structure important enough to have the stress in any of its parts computed must be in charge of a licensed structural engineer. This may have a salutary effect upon the country highway bridge business.

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More Civilian Officers for the Army Engineer Corps

A very, very narrow door is again opened by which engineers who are graduates of engineering schools other than West Point may possibly obtain a commission in the Corps of Engineers of the United States Army. The United States Civil Service Commission will hold examinations on Aug. 25 and 26 for candidates for the position of Junior Civil Engineer in the Engineering Department. In order to take the examination an engineer must be over 21 years old, either a graduate from an engineering school of good standing or have had at least four years' experience in engineering work. Those who pass this examination, provided they are not over 29 years old, are unmarried, and are graduates from an approved technical school, will be eligible for an examination to be held about Oct. 25 next of candidates for commissions as Second Lieutenants in the Corps of Engineers.

Of course, without knowing the character of the examinations to be given to the candidates in these two successive tests, one could not say definitely how large an opportunity is here presented for the enlargement of the Corps of Engineers from civil life. It is a good rule to judge the future by the past, however, and it is known that the much-advertised opportunities opened previously for engineering-school graduates to obtain commissions in the engineer corps have resulted thus far in the admission of just two men. Incidentally, and without prejudice, it may be said that every first-class engineering school in the country is superior to West Point, as an engineering school, and that the honor men of West Point who enter the Corps of Engineers are required to take supplementary work in engineering.

It is a question worth consideration whether the approaching session of Congress may not be a favorable time to put forward again the plan which has been before the engineering profession for more than thirty years of establishing the Federal Government's engineering works upon a basis that will be fair to the engineering profession. There is no doubt that preparation for national defense will be one of the things which will most seriously engage the attention of Congress, and there would seem to be good ground for argument that the army officers in the Engineering Department ought to be able to devote much more time to the military side of the profession instead of being occupied almost wholly in work which many believe should be in charge of civilian engineers.

Letters to the Editor

Using Barometric Leveling for Logging Surveys

Sir—In *Engineering News* of July 15, 1915, p. 132, appears a letter from James H. Bonner, professor of forest engineering at the University of Montana, criticizing the methods of making topographic surveys for logging purposes as described by me in an article in the June 10 issue.

The professor evidently missed one of the main points of the article—the fact that the work described is conducted "in the dense timber and thick brush of the coast country" and not in the open, scattering timber of the Rocky Mountain country nor in a park. The "Abney method" of leveling is ordinary trigonometric leveling, where the distances are measured with a tape and the angles with an Abney hand level or slope clinometer. If this method were substituted for barometric leveling by the topographers in a brushy country, it would require a couple of axmen to each topographer to cut out his lines and would decrease his speed one-third. This would increase the cost of taking the topography about six times and for a very doubtful benefit.

The professor may also mean that we should level over our parallel sight-compass lines, used as a base system for taking the topography, by the Abney method instead of direct leveling. These lines are from two to three miles long between transit lines, and usually have a total change of elevation of from 1000 to 3000 ft. Considering their nature, I do not believe that any practical engineer will take Professor Bonner's idea very seriously.

In comparing the costs of the two methods the professor fails to take into consideration the main cost items. He takes the cost of topographic surveys done by a slightly different method in a country totally free from brush and, if we dare say it, almost from timber, and compares it with the cost of work done in an almost tropical undergrowth. He overlooks the fact, or does not know it, that a country full of running streams is more broken up and more difficult to work in than the

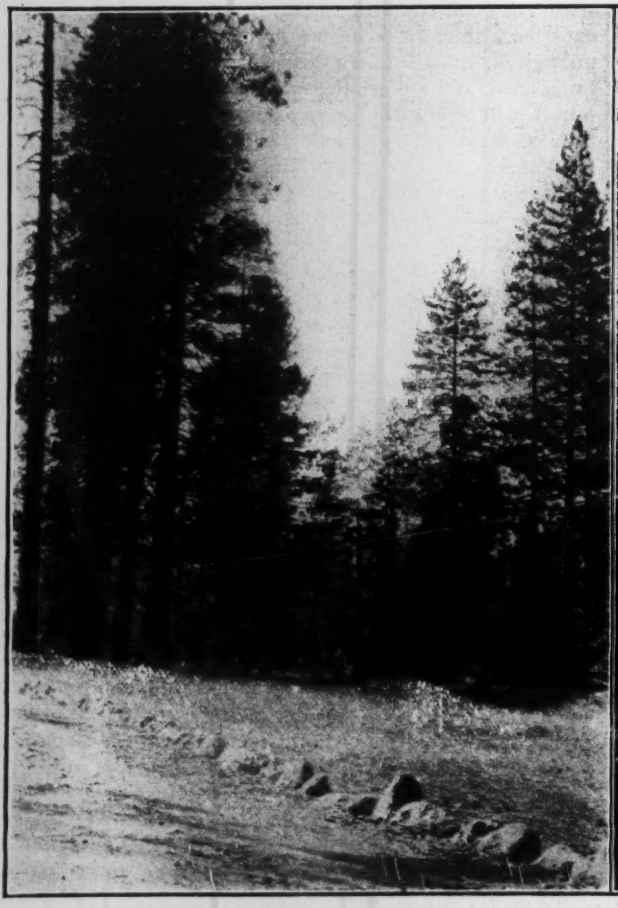


FIG. 1. OPEN TIMBER LAND OF THE ROCKY MOUNTAIN REGION

FIG. 2. DENSE UNDERGROWTH IN THE FORESTS OF THE PACIFIC COAST

regular slopes he is used to. So that your readers may see the difference more clearly, I am submitting views of typical wooded country. One of these shows open timber as in the Rocky Mountain region and the other typical woods of western Oregon and Washington, northwestern California and British Columbia. It is in this latter region that most of the timber is found, and it is here that the contour methods described in my article are particularly adaptable.

EARL A. MARSHALL.

Portland, Ore., July 24, 1915.

Earnings of Graduate and Nongraduate Engineers

Sir—An editorial in *Engineering News* of July 1, 1915, p. 33, in regard to the advertising of engineering schools states some facts in regard to the compensation of engineers in a way that may, I believe, be misunderstood.

Your statement that, "comparing . . . graduates . . . . with . . . nongraduates . . . the nongraduates were receiving the larger salaries," while in a sense correct, as shown by the reference (*Engineering News*, Jan. 7, 1915, p. 36), is in general incorrect, for the reason that in the diagram referred to the average for the graduates is brought down by the large numbers in the class of short-experience (low-pay) graduates. That is to say, there are many graduates working at low pay (to start), which reduces the average pay of graduates. Now the point is this: These statistics are for a special class—members of the American Society of Civil Engineers. There are not, as would appear from this, more graduates than nongraduates in the first years of the profession (quite the contrary), but of those of short experience who have joined the American Society, the relative proportion of graduates is large. This is because they are looking to a better future and also because they can better afford the expense of joining.

The following figures gathered by myself as to fifty engineers of less than five years' experience show that during this period also the graduates get more pay, though only slightly more:

Experience, Years	Graduates per Month	Nongraduates per Month
One	$67	$67
Two	86	78
Three	104	101
Four	110	110

These figures show that even at the start the graduates get more pay, and in later years the difference widens.

CIVIL ENGINEER.

Nashville, Tenn., July 31, 1915

[This letter makes it worth while to raise the question, When does the "experience" of an engineering-school graduate begin? If one desired to make a strictly fair comparison between the graduates and the nongraduates, ought he not to assume that the graduate engineer's experience began when he entered the engineering school, not when he graduated from it?

Here is a high-school graduate of 17 or 18 years. He can, let us assume, either get a job in an engineer's office or enter an engineering school and begin his actual work four years later. To make a fair comparison and ascertain whether he earns more money ten years later as a result of taking the engineering-school course, one should compare the salary of the man who has been working ten years in the field and office with that of one who has had six years of such work since his graduation.

Probably such a comparison would show an even poorer result for the graduate engineer than that given by our correspondent. Notwithstanding this, we assume that almost every engineer of large experience would advise a course in an engineering school for a boy who had the natural ability requisite for making a good engineer and whose parents could afford the expense.

It is a fact that a great deal of the routine work of the engineering office or survey party or inspection force can be learned in the school of hard knocks, and a good deal of it has to be learned there anyway. But the boy who aspires to do some day more than routine work, and who wants the stimulus of large ideas in the years while he is doing routine work makes no mistake in securing a thorough engineering education.—Editor.]

How Not To Build a Road

Sir—The design and construction methods now being used in building the section of the Paramus road between Arcola and Ridgewood, N. J., would seem to merit the condemnation of road builders, and it is difficult to believe that the finished road will be permanently satisfactory.

The old macadam roadway, although in an extremely worn and pocketed condition, will perhaps serve as a satisfactory foundation, but is not wide enough to include the proposed macadam strips alongside the new center. The new road is to consist of a central "Amiesite" roadway about 20 ft. wide, separated from side strips of macadam by concrete curbs. These curbs are only about 8 in. wide and 2 ft. deep and are without foundation or reinforcement. The macadam side strips will be new and apparently without any great amount of foundation. The question, then, is whether the curb will break, heave or move sideways, or whether the macadam side strips will sink below the level of the curb, leaving a permanent ridge on each side of the central strip.

Referring to the methods of work, it is to be regretted that there is no centralized authority having sufficient power to prevent dangerous and obstructive practices during road improvement. In the case of this road, the concrete curbs were built miles in advance of the filling, and after some months still remain as barriers along the driveway. In addition to the obstruction caused by the height of the curbs above the old roadway, there was left a gutter along each side of the curb. As the distance between curbs is only 18 or 20 ft. and the road surface is in very bad condition. It is not uncommon for vehicles to have to be jacked up out of the gutters.

R. D. C.

New York City, July 27, 1915.

Fruit Trees on Water-Works Drainage Areas—Robert B. Morse, Chief Engineer of the Maryland Department of Health, calls the attention of "Engineering News" to a report that the city of Frederick, Md., has received $1000 as its half of the peach crop from 4000 trees on land recently bought by the city to protect its water supply. The other half of the crop went to the tenant on the land. Mr. Morse adds:

It seems to me that, if proper sanitary precautions are observed during harvest season, many watersheds under municipal ownership might be made with safety to yield considerable amounts of revenue from fruit raising.

Many cities have planted forest trees on their water-works drainage areas. The returns from these are far more remote than from fruit trees, but a city can wait for revenue, and forestry operations present less danger of water pollution than does fruit raising.

Erie Rainstorm and Flood

SYNOPSIS—Remarkable rainstorm with three heavy downpours an hour apart produced a sudden flood in a hillside stream flowing through Erie. The discharges from the three periods of greatest rain synchronized. The creek channel was constructed by some twenty culverts, all overflowed.

A rainstorm of great intensity and remarkable distribution produced a destructive flood in Mill Creek in the city of Erie, Penn., on Tuesday, Aug. 3, 1915. About 200 houses were destroyed or damaged, and many persons were killed; at last accounts 35 dead had been found.

Contrary to press reports, no dams failed. The flood was nothing more than a phenomenal concentration of rainfall runoff, going beyond all past experiences. It rose high above the banks of a channel constricted by buildings alongside and over the creeks and by numerous culverts on which streets and railway lines crossed the creek. The flood was so great, however, that it might perhaps have overflowed even the natural unobstructed channel.

Mill Creek and Its Channel

Mill Creek is a short, steep brook running in a rock bed—shale under the earth cover is exposed along most of its course. The drainage area, according to the best data available, is about 17 sq.mi.[1]

The land slopes up southeastward from the Lake Erie shore at a fairly uniform rate of about 60 to 65 ft. per mile, except that a mile width along the lake is a plain about 60 ft. above lake level. The creek enters the city near the middle of its southern border, 2½ mi. from the lake, flows northwest toward the lake (i.e. straight down the slope) for a mile, then turns and flows directly north along a depression in the flat plain to the lake. A profile of the stream bed is almost exactly a straight slope; thus, the fall within the city is as follows:

26th St. (El. 131) to 18th St. (El. 98) 33 ft. in 2700 ft. = 1.22%
18th St. (El. 98) to 8th St. (El. 48) 50 ft. in 4100 ft. = 1.22%
8th St. (El. 48) to mouth (El. 0) 48 ft. in 4200 ft. = 1.14%

The channel averages from 30 to 50 ft. wide, and from 10 to 20 ft. deep; but on each side the ground slopes up from the top of the banks for a distance of from 500 to 600 ft., rising some 20 ft. in this width, so that the valley is a shallow trough with a narrow channel.

Between 26th St. and 13th St. the creek is paralleled on the west by State St., 150 ft. away; this is the main business street of the city. French St., occupied by dwellings, parallels the creek on the east at the same distance. Both streets lie in the valley trough, and both served as overflow channels for the flood waters, running from 4 to 8 ft. deep over the pavement in the worst period of Tuesday evening. But State St. lies slightly higher than French, and as the buildings along it form solid blocks they limited the cross-flow of water. The greatest destruction, therefore, was in French St.

After a wet July—with rain on 19 days out of the 31, and a total precipitation of 5.14 in. against the normal figure of 3.21—some rain fell in Erie on Aug. 2, but only a trace. The next day, however, rain started at 3:30 p.m. and continued 13 hr. to 4:42 a.m., Aug. 4, in which time a depth of 5.77 in. fell. Almost from the moment of starting, the rain was very heavy, and it became maximum in three great downpours lasting from 20 to 30 min. each; the last of the three, ending at 6:53 p.m., was the worst, and the flood-destruction followed soon after, 7:30 to 9 o'clock.

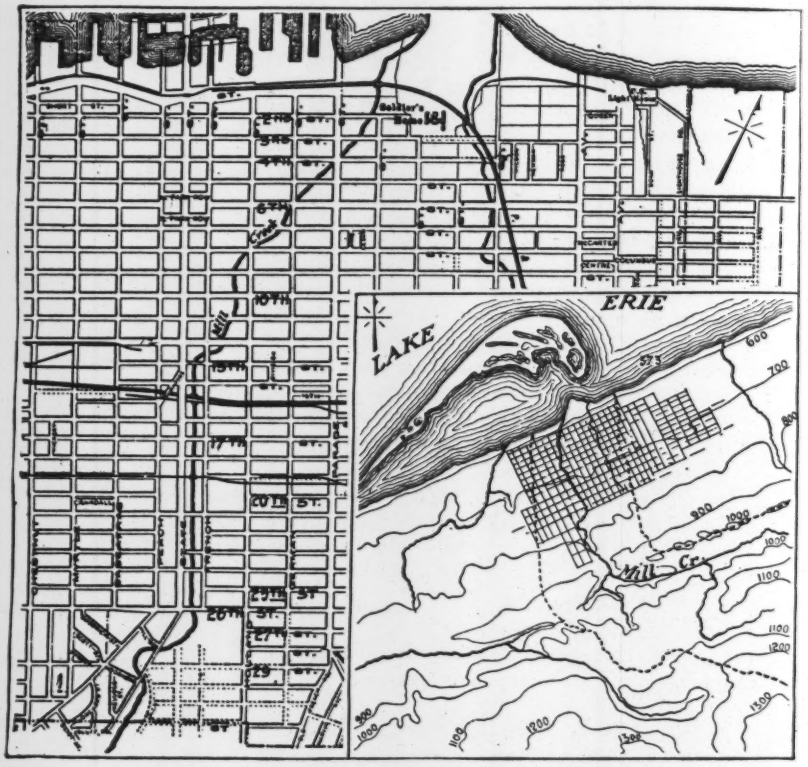


FIG. 1. SKETCH MAP OF ERIE, PENN., SHOWING COURSE OF MILL CREEK

The extraordinary character of the storm lies in its three high peaks occurring about an hour apart: At 4:20, 5:30 and 6:45 p.m., respectively, with precipitations of 0.9 in., 1.2 in., and 1.4 in. This feature is best shown in the curve of rainfall intensities, Fig. 2, which *Engineering News* has plotted from the rainfall records.[2]

[1] So stated by investigators of the State Department of Health six years ago. The city engineer has no figures from measurements of his own.

[2] Local Forecaster Harry O. Geren, head of the United States Weather Office at Erie, courteously made his records available and supplied the corrections and detail time readings from the autographic chart. He also directed attention to the fact that the record of the gage (at State and 12th St.) may be too low to represent the rainfall in the upper part of the Mill Creek area, two or three miles south of the city. His observation indicates that storm rainfalls may frequently be much higher in the hills south of the city, at an elevation of from 350 to 500 ft. above the lake, than in the city itself.

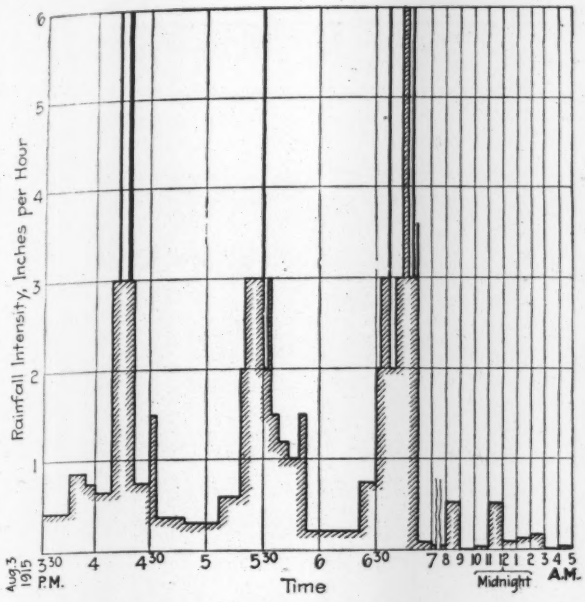


FIG. 2. INTENSITY CURVE

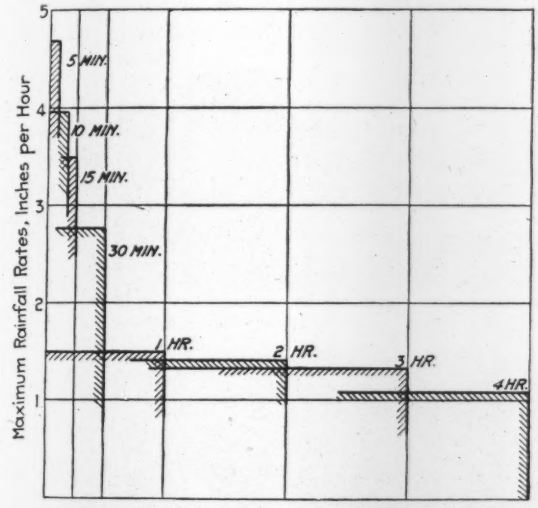


FIG. 4. MAXIMUM RAINFALL RATES IN ERIE STORM OF AUG. 3, 1915

The importance of this rainfall distribution is due to the fact that Mill Creek is so short and steep as to have a flood-concentration time of not more than one or two hours. City Engineer B. E. Briggs states that high water in Mill Creek ordinarily comes down within an hour or an hour and a half after the rain. On Aug. 3, therefore, the water of the second rainfall-peak flowed into the creek from the lower part of the drainage-area just when the first flood wave from the upper reaches went down through the lower channel; and with even greater effect the third rainfall-peak superimposed its runoff on the flood wave of the second peak.

A further picture of the three-wave character of the Erie storm is given by Fig. 3, which represents the curve of accumulated rainfall.

One interpretation of the storm is found in the figures for maximum intensity of rainfall maintained for various periods of time. The short-time intensities are high,

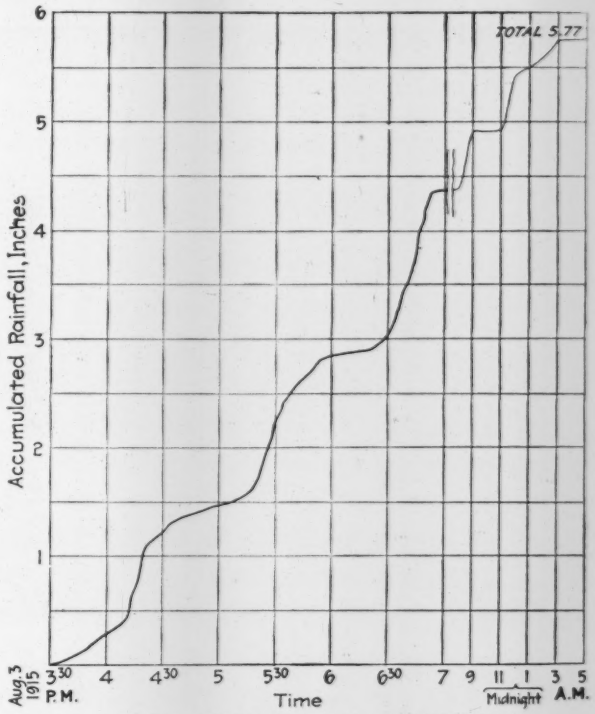


FIG. 3. ACCUMULATED RAINFALL

but not phenomenal; even the maximum 1-hr. fall was not exceptionally large. But the 2-hr., 3-hr. and 4-hr. rates are nearly as large as the 1-hr., being kept up by the succession of separate heavy downpours. The figures as computed by the local forecaster are:

Heaviest Periods	Precipitation, In.	Rate, In. per Hr.
5 min. (6:44-6:49)	0.39*	4.68
10 min. (6:43-6:53)	0.66	3.96
15 min. (6:34-6:49)	0.87	3.48
30 min. (6:24-6:54)	1.38	2.76
1 hr. (5:53-6:53)	1.50†	1.50
2 hr. (4:53-6:53)	2.84	1.42
3 hr. (3:53-6:53)	4.04	1.35
4 hr. (3:24-7:24)	4.31	1.08
Total	(3:30 p.m.-4:42 a.m.)	5.77‡

*Exceeded in August, 1913, with 0.41 in., rate of 4.92 in. per hr. †Exceeded June 27, 1900, with 1.67 in. in one hour. ‡Maximum rainfall in history of local weather office, 42 yr.

In diagram form these figures are represented by Fig. 4, which portrays clearly how the rainfall rate was held up to a nearly constant figure for all periods from 1 to 3 hours, by the succession of rainfall peaks. The curve makes it practically certain that a precipitation of at least 1.4 in. per hr. came into concentration; and in view of the saturated condition of the ground nearly the entire quantity must have appeared as runoff. For the 17-mile area this precipitation supplies a quantity of 15,000 cu.ft. per sec.

Dam, Bridges and Culverts

About half a mile outside the city, in a park, the creek is ponded by a low dam of the hollow reinforced-concrete type, built by the city ten years or so ago. It is about 5 ft. high, 40 ft. long, and has wing-walls 4 ft. high above the crest. Water flowed over the dam at least 7 ft. deep but did not injure it. However, the water washed out the ground at the west end of the dam, flowing around it, and also flowed over a 100-ft. length of bank east of the dam and along a road at the foot of the hill slope. Early reports had it that this dam broke in the flood and discharged its pond down upon the city; these reports were in error.

FLOOD DAMAGE IN MILL CREEK, ERIE, PENN.

A—Looking up Mill Creek from top of Commercial Bldg., 12th St. Note flow of water toward French St. at left. B—Washout of Nickel Plate embankment, showing old filling trestle. Concrete culvert shows at left; old stone piers belong to an earlier girder span. C—At Second St.; large washout at east side of culvert (to right). D—Washout west of culvert at 22nd St.; a typical case. E—Washout alongside concrete arch culvert at Fifth St.; back of arch abutment at right of view. F and G—Washout at 26th St., over 100 ft. wide, with only the downstream headwall left of the culvert. Views east and north respectively

In the half mile between the dam and 26th St., where the stream enters the built-up area of the city, one bridge remains (it was bypassed by a broad flow over low marsh ground to the west) while two bridges were carried out. They were overflowed about 5 ft. over the floor. The lower of the two had previously been overflowed slightly.

At 26th St. is the first of a series of 20 street crossings over the creek; in addition two railways cross, the Nickel Plate by a 20-ft. concrete arch culvert in its embankment, the Lake Shore & Michigan Southern by a 24-ft. stone arch. The street crossings are all made by 20-ft. culverts, most of them brick with concrete arches with upwards of 6-ft. rise, but a few are flat concrete spans. The height of the culvert roadway ranged from 10 to 25 ft. above creek bed. All the culverts were overflowed several feet, but only two were carried out. Washouts of embankment occurred at many of the others, however. The water flowing through these washouts and along the nearby streets was the direct cause of practically all the destruction of houses and loss of life.

The condition of the creek channel was determined not alone by the presence of the culverts, but by numerous sections of retaining-wall or channel wall. For several blocks in the middle of the city private abutters had built walls along both sides, 20 ft. apart and less than 20 ft. high, and at one or two points these sections were even covered by platforms or by buildings. Being founded on solid shale, the walls in most cases remained uninjured; a few were overturned by the pressure of the earth backing.

Further, at the diagonal crossings under street intersections in the lower section of the creek, as at Sixth St. and at Fourth St., the necessary length of the culverts—several hundred feet—operated to limit the flow capacity.

Underscouring of foundations of buildings did some damage, but more was done by the push of the flowing water shoving frame houses off their foundations and wrecking them.

Débris carried down by the creek on the rise of the flood was a large factor in increasing the damage. Trees, wreckage of houses and bridges, etc., blocked culvert openings and thus raised the flood level and diverted more water through the streets. Apparently this effect was mainly local.

Of the many peculiar effects of the flood on the structures along and over the channel, the destruction of the 26th St. culvert is particularly interesting. This was a stone arch with rather deep fill over it, bringing the roadway 24 ft. above creek bed. Three years ago its headwalls were found to be in bad condition, and the downstream wall was rebuilt in concrete. The flood tore out the arch (it is claimed by the blocking effect of the débris of the two road bridges washed out just above), besides washing out sections of the street embankment on either side, making a gap of 150 ft.; but the concrete headwall on the downstream side still stands.

The sudden failure of the 20th St. embankment is charged by many with doing the worst part of the flood damage. Occurring when the flood already was high, it is said to have sent a sudden rush of water down the channel, which acted as a destructive wave.

The Nickel Plate was cut in two by the washing out of 200 ft. of embankment from the creek to French St., although the concrete culvert was left standing, bare but uninjured. The same thing occurred at many of the street culverts. Eddies caused by the deflection of the water currents probably produced the erosion of the embankments. In at least one case the erosion did not work through the entire thickness of the roadbed, but left the pavement supported along the downstream side while the upstream side spanned a gap.

Sewers and Piping

The sewer system of the city was little damaged, in spite of the fact that there are 43 public sewer outlets into the creek and a large sanitary intercepting sewer alongside the creek for over a mile. Two large sewer outlets blocked by dirt and débris, and some minor damage, are reported. The water system and other piping systems were also little damaged. The natural-gas supply was interrupted by a break in the line, and the public lighting system was paralyzed.

The local health authorities are being assisted by men from the state health department in taking care of sanitation and disease prevention. Engineers of the state Water-Supply Commission are studying the flood phenomena and gathering data on the flood flow.

The above account is based on personal observation and on information given by City Engineer B. E. Briggs, Local Forecaster Harry O. Geren, and others.

ENGINEERING SCHOOLS

University of Arizona

A new system of short courses has been arranged for all mining men desiring to improve their knowledge of the industry. In arranging these courses the requirements of three classes of men have been kept in mind: (1) Young men of common-school education who may become shop bosses, floor and furnace foremen, etc.; (2) young men with a high-school education who can be trained to be mine or mill foremen and for other positions requiring partial technical training and sound practical experience; (3) graduates of scientific schools who need training, especially for administrative work.

For the first group a series of different short courses two weeks long have been arranged. Each subject is to be given alone and intensively, taking up both theory and practice. The subjects will follow each other in logical order, and a student may select as many courses as he wishes. For the second group it was considered that practical experience in successful mines and reduction works was more needed than additional training. The regular four-year course is recommended for these men with half of each week in the last year given up to applications of theory at successful properties within reach of Tucson. For the third class a graduate school has been organized giving advanced courses.

Pennsylvania State College

A summer school of scientific management is now in progress. This session is planned for the accommodation of works managers, superintendents, heads of departments and all others interested. The time is restricted to two weeks to meet the needs of employees whose vacation period is limited to that time. The shops have been especially provided with means for teaching and demonstrating applied methods of scientific management.

Extensive Earth Slippage Shuts Down Cement Plant

SYNOPSIS—Clay surface slips toward creek in vertical slices 50 ft. wide by 20 to 30 ft. deep, causing $250,000 property damage and five deaths. Area of disturbance, 15 acres. Knickerbocker Portland Cement Co., Hudson, N. Y., will be shut down for months until new power station can be erected and equipped.

The extensive subsidence which shut down all operations at the Greenport plant of the Knickerbocker Portland Cement Co., near Hudson, N. Y., on Aug. 2, as noted in *Engineering News* of Aug. 5, was apparently the result of the successive slippage of large slices of the clay soil in the direction of Claverack Creek. The first visible incident in the disturbance was the movement of a section of earth 50 ft. wide by at least 30 ft. deep and 200 ft. long,

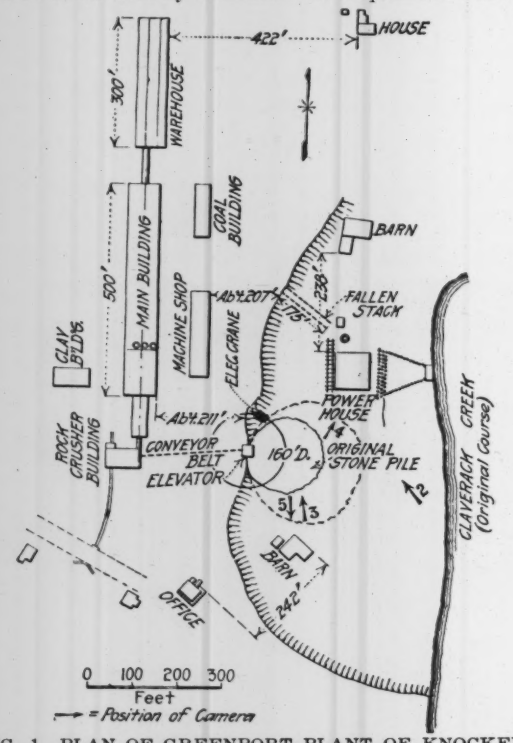


FIG 1. PLAN OF GREENPORT PLANT OF KNICKERBOCKER PORTLAND CEMENT CO.

about 200 ft. southeast of the power house, and this section toppled over into the creek flowing 120 ft. east of the power house. This slide was followed immediately by others in ever-lengthening arcs, until a huge storage pile of crushed traprock was undermined. The pile then sank 20 to 25 ft. over its area (160 ft. in diameter). This sinkage caused the settlement and destruction of the coal trestle and power house, in the order mentioned. Witnesses state that the last objects to be disturbed were the crane and elevator tower used in connection with the circular storage system.[1]

[1]This system, produced by the Link-Belt Co., Chicago, Ill., was described briefly in "Engineering News" of July 15, p. 126.

The disturbance extends over 15 acres of ground. The creek was pushed from 40 to 200 ft. out of its original course and its channel was dammed so that a new channel had to be blasted almost immediately to prevent the flooding of the plant. The water in the Claverack is from 6 to 8 ft. in depth. The entire earth movement was over in 2½ min. The total damage will probably reach $250,000.

Soil and Topography

The buildings of the company are on flat footings with no piling. The soil is the blue clay common to the Hudson Valley. The general slope is toward Claverack Creek (30 ft. wide) which bounds the company's property on the east, the water level being about 15 ft. below that of the property. The slope is about 1 on 2.

Local reports speak of a substratum of quicksand, but inspection of the site and the geology of the country do not support this theory.

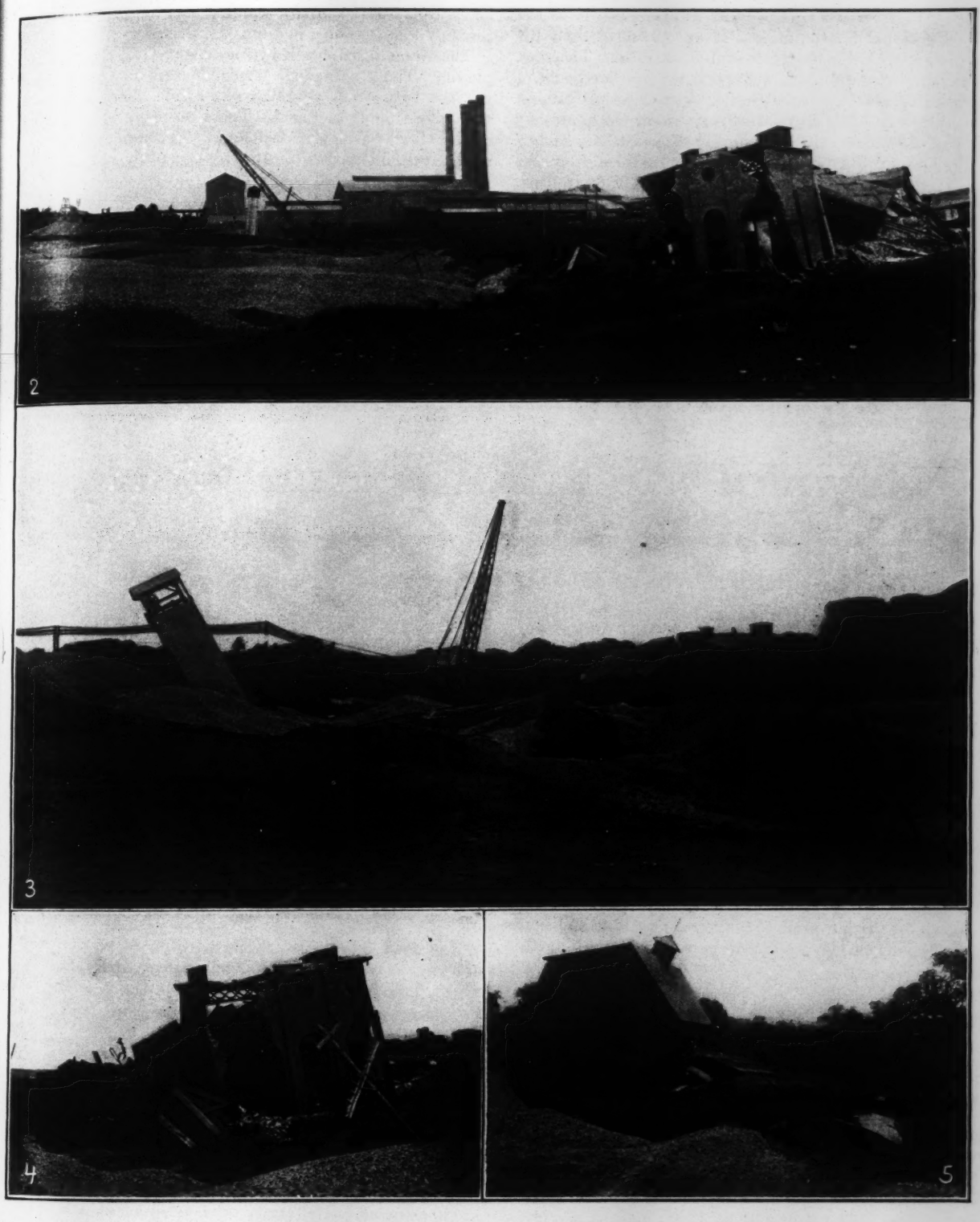
The nature of the slippage indicates that water seeping through cracks at the foot of the bank caused a section of the bank to cave in, and this started a succession of similar movements, each farther away from the creek than its predecessor. Whether a lateral flowing of the clay subsoil under the heavy superincumbent load had anything to do with the caving cannot be determined.

Other slides have occurred along the line of this creek in the past ten years or more, though only one of serious nature is on record. In the fall of 1914 a small slide occurred at the power house. Warning of this was given by the parting of several pipes. Back of the building and between it and the creek was a cinder fill; after the slide this was protected by a group of wooden piles driven to a depth of 40 ft. in the manner shown in Fig. 1. No subsequent disturbance occurred, certainly none after February, 1915.

Damage to Buildings

The greatest damage was caused at the power house, not only because of the value of the building and equipment, but also because the entire cement plant depended upon it for power. This building had concrete foundations and a brick superstructure, and contained six 402-hp. Heine water-tube boilers, which supplied steam to two 2000-kw. Curtis turbo-generators. Alongside the building and between it and the stone pile was a timber coal-trestle. The subsidence of the rock pile apparently caused the trestle and the power house to collapse, as shown in Fig. 4. The boilers did not burst, but escaping steam from broken pipes caused the death of five men. The turbines were located in the right-hand portion of the station, as viewed in Fig. 2, where they are visible in the wreckage.

On the creek bank east of the turbine room was located the reinforced-concrete condensing-water intake house. This settled at one end, because of being undermined, but was otherwise undamaged. A reinforced-concrete chimney, 175 ft. high, located behind the power house, appears to have slid away from the creek about 75 ft. before falling over in the direction of its motion. The stack turned over intact from its base and flattened under the impact of its fall; it now lies in the position indicated on Fig. 1.



VIEWS TAKEN IN ZONE OF DISTURBANCE, SHOWING DAMAGED STRUCTURES

Fig. 2—Panorama of settled area; stone pile at left was formerly 45 ft. high; note sharp bank formed in front of main plant buildings. Fig. 3—Elevator tower and crane used in the circular storage system, with collapsed power house in the distance. Fig. 4—Near view of the wrecked power house. Fig. 5—Barn out of plumb in the zone of subsidence, on opposite side of stone pile from power house

The 30,000 to 40,000 tons of traprock in the huge pile which sank formed a part of what was intended to be the winter's supply for the mills. It was intended that this supply should ultimately exceed 100,000 tons. The rock was transported from the quarry to the crusher house, a distance of less than a half-mile, by cars which entered the crusher building on the trestle shown at the upper left of Fig. 2, and in the drawing in Fig. 1. An underground belt conveyor carried the crushed rock from the crusher house to a reinforced-concrete elevator, 60 ft. high, located in the middle of the storage area. There it was lifted to a chute and dumped onto the pile, to be rehandled to any point in the storage area by a 2-yd. 65-ft. radius electric crane, running on a circular track 160 ft. in diameter. The arc of the crane track which lay within the zone of subsidence sank with the crane, but the latter was undamaged (see Figs. 1 and 2). The elevator settled 30 ft. and swung far out of plumb, but does not show any structural damage other than minor cracks.

Part of the roof of the reinforced-concrete packing house collapsed when the building was affected, but fortunately the day force had not yet arrived.

The frame barn shown in Fig. 5 settled 45 deg. out of plumb. The touring car which appears to be preventing the barn from slipping was inside, being cranked, when the trouble occurred. The steep bank at the right of the view is a blowup formed by the subsidence. Part of the rock pile is shown in the foreground.

Plans for the Immediate Future

While plans for rebuilding the power plant and the other damaged structures are necessarily unsettled just now, arrangements are under way tending toward the resumption of business at the earliest possible date. The power station cannot, of course, be replaced for several months. In the meantime, a certain amount of electric power will be bought from the Albany Southern R.R. Co. Myron Hammond is Superintendent of the Knickerbocker Portland Cement Co.

News of the Engineering World

An Engineer Wanted

The Upper Scioto Drainage and Conservancy District, with headquarters at Kenton, Ohio, expects to proceed with the preparation of a plan of flood prevention, drainage and conservation for that portion of the drainage area of the Scioto River which is within Hardin County. The directors of the district, through a notice signed by Kent P. Johnson, attorney and acting secretary for the district, have invited proposals until Aug. 21 for "performing the engineering services necessary and incident to the formation and adoption" of a plan for the proposed work. The services of the engineer are "to be advisory and supervisory only." The engineer is to engage the necessary staff for the work, both engineering and clerical, and the district is to pay the actual expense of the staff. Proposals for the engineering services just outlined may be made in writing prior to 9 a.m., Aug. 21, or applicants for the position may appear in person at Kenton on that date.

Watervliet Water-Supply Plans

The plans and specifications have recently been completed and bids have been asked for the new municipal water-works of Watervliet, N. Y. These show in detail what has been previously outlined in these columns. The water is to be obtained from the Normanskill at French's Mills, in the town of Guilderland, about 12 mi. west of the city of Watervliet. At this point there will be a reservoir formed by building a reinforced-concrete dam across a rocky gorge. The dam will be 36 ft. high at maximum section and 380 ft. long, with a spillway of 324 ft. The reservoir will cover an area of about 460 acres and will have a capacity in the top 10 ft. of 1120 million gallons.

About 1400 ft. downstream from the dam will be a power station with two hydraulic turbines directly connected to two centrifugal pumps, each having a capacity of 2¼ million gallons per day. The pumps and turbines will be served from the same water-supply. A force main will run to a 15 million-gallon service reservoir just outside Watervliet. This main will be of cast-iron, or of wood pipe with a few cast-iron sections. The service reservoir will have four earth walls and will be partly in cut and partly in fill. The inside slope will be lined. Between the service reservoir and the city distribution line will be a 3 million-gallon filter plant with aerator and clear-water well. In the city there will be about 22 mi. of cast-iron pipe of from 4- to 14-in. diameter.

Railway Line Surveyed by Engineering Students

The news bulletin issued by the Ohio State University on Aug. 6 contains the following item under the title "New Traction Line Under Construction":

"The Cleveland & Ohio Central Electrical Ry. is the name given to the traction line which is to run between Wooster and Cleveland," said Prof. C. E Sherman, of the department of civil engineering of the Ohio State University. "A final survey, which was conducted by the university, has been completed. The road will bisect a strip of territory some 15 mi. wide which has no railroad nor traction facilities at the present time. The final survey was made by the department of civil engineering of the Ohio State University.

"This work constituted the annual summer camp for civil engineering students this summer. Three parties were placed on the survey, in charge of Instructors R. C. Sloane, G. F. Schlesinger and W. Neilson. The work was completed at an estimated cost of $1200. Other work undertaken by the summer camp was the making of a topographic survey of parts of the Ohio State University farm, and in addition a cemetery in Springfield, Ohio.

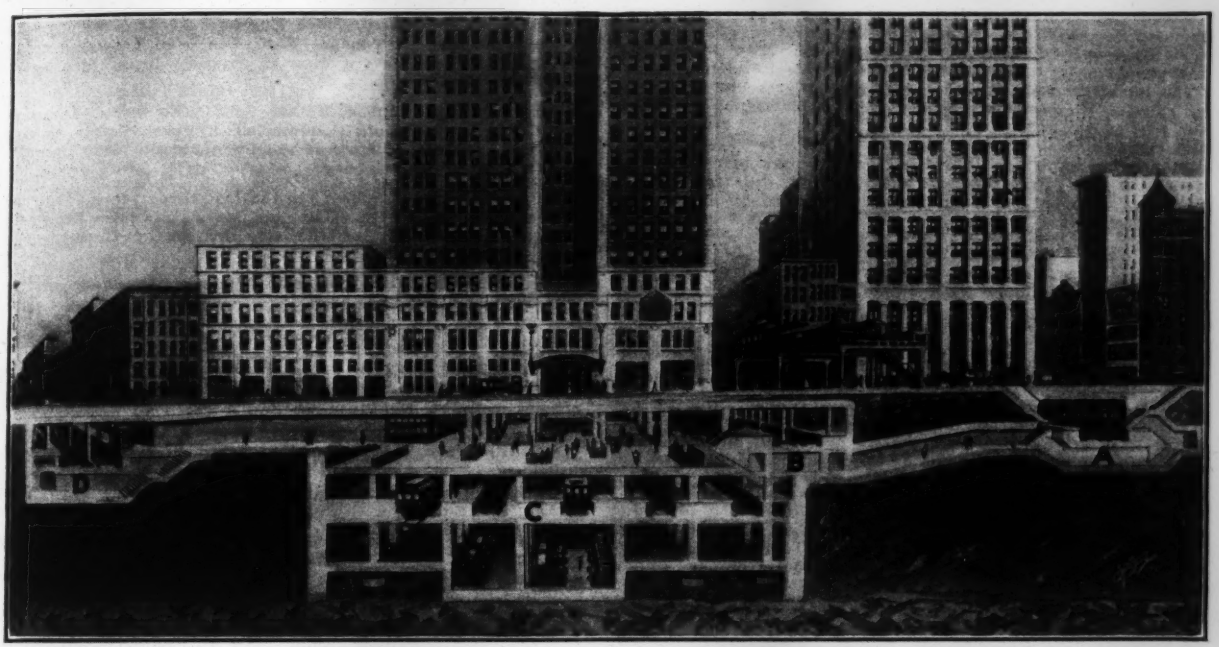
"The location chosen for this line is very nearly ideal. At no place is there more than a 2° grade, and the sharpest curve is but 3°. One of the features of this road will be the using of gasoline-electric cars. The electricity will be gen-

erated by gasoline engines located in the car, and will afford convenient driving power.

"It is now the intention of the company to continue the line at a later date to Columbus and ultimately to Cincinnati, thus affording a continuous air line from the southwestern part of the state to the lakes."

Downtown Union Subway Station, New York City

There are four principal union or intercommunicating stations in the new dual subway rapid-transit system of New York City. One is at Times Square, 42nd St. and Broadway; the second is at the Grand Central Station, a wash drawing representation of which was given in *Engineering News* of Oct. 24, 1912; the third is at Brooklyn bridge and the Municipal building, and the fourth is at Dey St., between the Hudson Terminal buildings. A reproduction of a wash drawing of this latter station is shown herewith.



DOWNTOWN UNION SUBWAY STATION, NEW YORK CITY; CROSS-SECTION THROUGH DEY ST.
Reproduced from a wash drawing by courtesy of J. Vipond Davies, Chief Engineer of the Hudson & Manhattan R.R.

The Dey St. station is of particular interest because it gives connection with all the northbound and southbound subway trains of lower Manhattan. In the accompanying illustration *A* is the present Interborough Rapid Transit Co.'s Broadway-Fourth Ave. line; *B* is the Brooklyn Rapid Transit Co.'s Church St.-Broadway line now under construction, which extends south to Brooklyn through two new Battery tunnels now being built and north under St. Paul's churchyard to Broadway. Above *B* is the Sixth Ave. elevated line of the Interborough Rapid Transit Co. The letter *C* indicates the downtown terminal station of the Hudson & Manhattan R.R., which runs to Jersey City, Hoboken and Newark; *D* is the new Seventh Ave. line of the Interborough Rapid Transit Co.'s subway, which is to go south to the present Battery tunnels of that company and north to Times Square. Above *C* is the present Ninth Ave. elevated line of the Interborough Rapid Transit Co. Four blocks north of the point *C* this new subway has a branch extending east under Park Place, thence to William St., to Old Slip, where two new tunnels are being built under the East River to Brooklyn.

Thus a person coming from New Jersey or arriving at any of the railway terminals on the Jersey side of the Hudson River between the Pennsylvania R.R. and the Delaware, Lackawanna & Western R.R. stations may reach any point on the Manhattan, Brooklyn, Queens and Bronx rapid-transit system without emerging into the light of day, so to speak, or he may go direct to the Grand Central station and away again without seeing anything but a subterranean city.

A Second-Hand Bridge Falls—On July 28 a 240-ft. span on the south end of a highway bridge between East and South Aberdeen, Wash., fell into the Chehalis River. It carried with it an automobile in which were five persons, none of whom was injured. A street car had crossed the bridge a few minutes before the accident. The bridge was a combination timber and steel structure and formerly spanned the Willamette River at Portland, Ore., until condemned as inadequate for the service to which it was there subjected. It was placed in its present position in 1905 and operated as a toll bridge. A few years ago the steamer "Norwood" smashed into the same span and pushed it into the river. From accounts of witnesses, the middle of the span began to sag and totter and finally gave way.—Roy A. Klein.

Permits for Liquid Chlorine Water-Disinfection plants to be installed by the Annapolis Water Co. and by the Piedmont Water-Works Co. at Annapolis and Piedmont, Md., have been issued by the Maryland Department of Health.

Electrification of Railways Entering St. Paul, Minn., is contemplated by an ordinance introduced in the City Council by Oscar Kellar, Commissioner of Public Utilities. The ordinance forbids the use of steam locomotives within the city limits. A delegation of railway employees appeared before the City Council on July 12 to oppose the adoption of the ordinance.

An Engineers' Special Train from New York to San Francisco is to be run over the New York Central Lines and Santa Fé system, leaving New York on Sept. 9. Accommodations on

the train have already been reserved by members of the national engineering societies and their friends sufficient to fill 11 cars. Stops will be made on the way at Niagara Falls, Colorado Springs and the Grand Cañon.

Electrification of the Railways Entering Cleveland is to be investigated by a special committee of the City Council appointed July 12. The committee will make use of data and specifications prepared in 1913 by E. T. Roberts when city smoke inspector. This report recommended that on several of the railways entering Cleveland electrification be extended into the suburbs beyond the city limits.

Plans for a Sewerage System and sewage-treatment Works for the Little Falls Branch drainage area of Montgomery County, Maryland, are being made for the county commissioners, in compliance with an order of the State Department of Health. The preliminary estimate of cost is $125,000. The project follows the recommendations of a report on sewage collection and disposal in the vicinity of the District of Columbia, recently made by the Department under the direction of Robert B. Morse, Chief Engineer.

Fixing Rates for Public Utilities by snap legislation in the State of New York may be checked in future if the constitutional amendment should adopted which has been recommended by the Committee on Public Utilities of the State Constitutional Convention now in session. The amendment recommended by this committee contains the following clause: "The legislature shall not enact any law prescribing a rate, or charge, or a standard of service, equipment, or operation for any public utility until after it has received from one of the commissions a report thereon made after investigation and hearing at which interested parties may introduce evidence, or until after the expiration of such time following a request for such reports as may be prescribed by law."

United States Public Land Surveys—All records were broken during the last fiscal year in the making of surveys of public lands, according to reports submitted to Secretary Lane by Commissioner Tallman, of the General Land Office. The total of accepted and approved surveys aggregated 14,339,349 acres. This was nearly double the amount surveyed during the preceding year and 4,589,872 acres more than was surveyed in 1909, the previous high-record year. These surveys are made, not by the contract system with private surveyors, as was the practice for half a century, but by the direct-survey system put into operation two years ago, whereby all of the 150 surveying parties are made up of regular employees of the Department of the Interior. Greater accuracy and efficiency have resulted from this system.

Progress on the Rogers Pass Tunnel of the Canadian Pacific Ry. has been very satisfactory. It will be remembered that this 5-mile double-track tunnel is being driven from intermediate headings reached by crosscuts from a pioneer tunnel or heading parallel to but outside the line of the main tunnel ("Engineering News," Apr. 2, 1914). The pioneer heading has been completed and there remain to be driven 2.05 mi. of main heading and 3.31 mi. of enlargement to the double-track section. The concrete lining of the earth section is nearly completed, and it is expected that the concreting of that portion of the rock section which requires lining will be finished during this year. The tunnel will probably be completed and ready for operation in September, 1916. The progress made during 1915 is given, from a statement furnished by Foley Bros., Welch & Stewart, the contractors. A. C. Dennis is superintendent for the contractors.

	East End			West End		
1915	Pioneer Heading, Ft.	Main Heading, Ft.	Enlargement for Double Track	Pioneer Heading, Ft.	Main Heading, Ft.	Enlargement for Double Track
January ...	592	443	443	932	699	210‡
February ..	620	440	422	650	634	247
March	595	196*	379	617	752	413
April	751	442	553	569	741	588
May	658	417	718	730	618	685
June	776	471	659	808	393	729
July	682	538	726	731	969†	812

*Half-month. †Two headings. ‡Timbered.

An Investigation of the Lumber Industry of the United States is to be undertaken by the Federal Trade Commission in coöperation with the Forest Service and the Bureau of Foreign and Domestic Commerce. The forest resources of the United States are being depleted at the rate of 80 billion feet or more per year. Lumber prices, however, have continued on a low level for a number of years, and the admission of lumber from the North Pacific coast to Atlantic-coast markets through the opening of the Panama Canal is likely to prevent any material advance in prices for at least a dozen years to come. Where an increase in market prices of lumber has taken place, it appears to be due to an increase in stumpage prices obtained by owners of standing timber and possibly to longer freight haul, since lumber is now brought in general from greater distances. One unfortunate result of these low prices is that much low-grade timber is not marketable. Consequently, notwithstanding the rapid inroads on the country's forest reserves, the annual timber consumption continues undiminished.

PERSONALS

Dr. Wm. J. Gallivan has resigned as Health Commissioner of the city of Boston, Mass.

Mr. E. H. Olson has been appointed Office Engineer of the Atchison, Topeka & Santa Fé Ry. at Topeka, Kan., succeeding Mr. M. C. Blanchard, promoted as noted elsewhere.

Mr. Samuel M. Gray, M. Am. Soc. C. E., a consulting engineer of Providence, R. I., has been appointed Consulting Engineer of the Providence Water Supply Board at an annual salary of $10,000.

Mr. M. C. Blanchard, Office Engineer of Atchison, Topeka & Santa Fé Ry., at Topeka, Kan., has been promoted to be Engineer of the Eastern district, Eastern lines, with headquarters at Topeka.

Mr. H. P. Drake, Assoc. M. Am. Soc. C. E., former Assistant Engineer, Water-Supply Commission of Pennsylvania, is now with the engineering staff of the Pennsylvania State Department of Health, Harrisburg.

Dr. Francis X. Mahoney, for the last three years Chairman of the Board of Health of Boston, Mass., has been appointed Health Commissioner of the city by Mayor Curley, at a salary of $7500 per annum.

Mr. Ross M. Riegel, former Division Engineer of the Water-Supply Commission of Pennsylvania, has taken a position with the Morgan Engineering Co., Dayton, Ohio, on the proposed flood-protection work.

Mr. Gilbert J. Bell, recently Division Engineer of the Atchison, Topeka & Santa Fé Ry., at Marceline, Mo., has been promoted to be Engineer of the Western district, Eastern lines, with headquarters at Newton, Kan.

Mr. H. T. Gritchlow, formerly a member of the engineering staff of the Water-Supply Commission of Pennsylvania, is now a member of the United States Geological Survey on hydrographic work, with headquarters at Madison, Wis.

Mr. Gerard Hendrik Matthes, M. Am. Soc. C. E., formerly Division Engineer of the Water-Supply Commission of Pennsylvania, has accepted a position with the Morgan Engineering Co., Dayton, Ohio, on the proposed flood-protection work.

Mr. P. L. Pierce, Assoc. M. Am. Soc. C. E., former Assistant Engineer, Water-Supply Commission of Pennsylvania, is now a member of the engineering staff of the Wisconsin River Power Co., in charge of the construction of transmission lines near Madison, Wis.

Mr. W. F. Faber announces that the Faber Engineering & Construction Co. has opened offices in the Bessemer Building, Pittsburgh, Penn., for the conduct of a general contracting business, specializing in sewage disposal and reinforced-concrete construction.

Mr. E. W. Lewis, M. Am. Soc. C. E., formerly Assistant Engineer of the New York, New Haven & Hartford R.R., at New Haven, Conn., announces that he has opened an office for the general practice of civil engineering at 234 Union St, New Bedford, Mass.

Mr. H. B. Phillips, M. Am. Soc. C. E, Valuation Engineer of the Atchison, Topeka & Santa Fé Ry., at Chicago, Ill., has resigned to become Assistant Secretary of the Presidents' Conference Committee on the Federal Valuation of Railroads, with offices in Chicago.

Mr. Lewis Littlepage Holladay, M. Am. Inst E. E., former Consulting Engineer of the McLeod Manufacturing Co., Chicago, Ill., and Mr. Henry Nedstad announce the formation of the firm Holladay, Nedstad & Co., Consulting Engineers on power plant utilities and industries, with offices at 109 No. Dearborn St., Chicago.

Mr. John N. Carlisle, former State Highway Commissioner of New York, has resigned his position with the State Highway Department, which he has held since last spring, when he was superseded as Commissioner by Mr. Edwin

Duffey. Since his resignation as State Highway Commissioner Mr. Carlisle has been retained in an advisory capacity at a salary of $33 per day.

Mr. Thomas J. Gannon, M. Am. Soc. M. E., recently Mechanical Engineer of the Department of Water Supply, Gas and Electricity, New York City, announces that he has opened an office at 143 Liberty St., New York, for the practice of mechanical and hydraulic engineering, specializing in power plants, water-supply and sewage disposal, coal and fuel economy and mechanical equipment and testing.

Mr. D. F. Stickley, M. Am. Soc. C. E., for several years Supervising Engineer of the New York State Barge Canal, and for the past year Consulting Engineer of the Lake Erie and Ohio River Canal Board of Pennsylvania, in charge of preliminary investigations for the proposed waterway, has returned to Albany, N. Y., where he has opened an office in the Arkay Building for the general practice of civil engineering.

Mr. H. S. Philips has been granted leave of absence from his duties in the city engineering department, Toronto, Ont., to accept the position of Assistant Engineer in the Buffalo, N. Y., office of the International Joint Commission, under the direction of Prof. Earle B. Phelps, of the United States Public Health Service. A part of the work of this commission is the investigation of a means for the control of the pollution of the Niagara River.

Mr. Edward W. Parker, M. Am. Inst. M. E., whose resignation as Chief of the Bureau of Coal Statistics of the United States Geological Survey was noted in these columns of May 13, 1915, is now in charge of the Anthracite Bureau of Information, supported by the anthracite coal mining operators of the United States, with offices at 1032 Miners Building, Wilkes-Barre, Penn. The work of this bureau has been combined with that of the Bureau of Anthracite Coal Statistics, which was formerly under the direction of the late W. W. Ruley, and since his death in charge of Mr. A. A. Armstrong. Mr. Armstrong will remain in charge of that portion of the work.

Mr. E. C. Black, Assoc. M. Am. Soc. C. E., formerly of the firm of Worley & Black, Reliance Building, Kansas City, Mo., announces the reorganization of the firm under the name of Black & Veatch, with offices in the Inter-State Building, Kansas City, Mo. Mr. J. S. Worley, M. Am. Soc. C. E., resigned from the firm of Worley & Black Jan. 1, 1914, in order to give his entire attention to the Interstate Commerce Commission's railway valuation work. Mr. N. T. Veatch, Jr., Assoc. M. Am. Soc. C. E., of the new firm, was formerly Assistant Engineer of the Kansas State Board of Health and for the past year and a half has been with the American Water-Works & Guarantee Co., of Pittsburgh, Penn.

Mr. H. M. Roy, formerly Chief Field Engineer with the American Zinc & Chemical Co. on the construction of its zinc smelter plant, modern town and coal mine at Langeloth, Penn., has accepted the position of the Stone & Webster Engineering Corporation at Keokuk, Iowa, on construction of a zinc-smelter plant. He was graduated from the University of Illinois in 1905, and after spending two years in the United States Coast and Geodetic Survey on harbor surveys and precise leveling, entered the engineering department of the Pennsylvania Lines West of Pittsburgh, where he was engaged on various construction and maintenance work until 1913, when he left the railroad to accept the position with the American Zinc & Chemical Co.

OBITUARY

Alexander Dempster, a prominent Pittsburgh business man and formerly an engineer employed on the low grade division of the Allegheny Valley R.R. (in 1869 to 1870), was killed in an automobile accident near Ligonier, Penn., on Aug. 2. About 1871 he was assistant to W. H. Kennedy, M. Am. Soc. C. E., on city work in Pittsburgh, Penn., and from 1872 to 1876 was City Engineer

Henry Stephen Hawley, President of the Railroad Supply Co., of Chicago, died July 28 at his home in Saunderstown, R. I., at the age of 64 years. In earlier life he was a prominent railroad contractor and had a contract in the seventies for the construction of a section of the Grand Trunk Ry. in Indiana and Illinois. Later he held various offices with the Chicago Great Western R.R. and Chicago & Northern Pacific R.R. (later the Northern Pacific Ry.).

Charles Dod Ward, M. Am. Soc. C. E., died at his home in New York City, July 30, at the age of 78. For several years previous to 1910 he was an engineer in the Department of Water Supply of Brooklyn. Mr. Ward achieved considerable fame in 1904 when he presented to the American Society of Civil Engineers a paper on the then proposed earth dam for the Panama Canal, in which was first suggested that the dam be located at Gatun instead of at Bohio, as was then being considered by the Isthmian Canal Commission. Mr. Ward's investigations and clear-cut suggestions, which were included in the Commission's report, had much to do with the final location of the great earth dam at Gatun. He was one of the oldest members of the American Society of Civil Engineers, having been elected in 1869.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 24-27. Annual convention in Cincinnati. Secy., Clarence R. George, Houston, Tex.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

San Francisco Meetings

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 19-21. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.; until Aug. 1, New Stockton, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

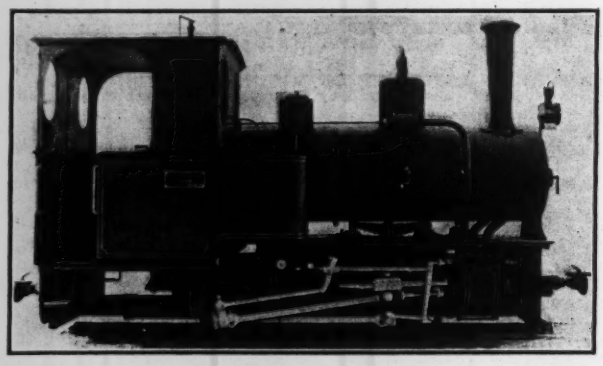
AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

Appliances and Materials

Dinkey With Underhung Tank

Dinkey locomotives generally carry their water-supply in a saddle tank over the boiler, but the illustration herewith shows an engine having the tank fitted between its plate frames. This lowers the center of gravity, tends to make the engine more steady, and reduces the liability of derailment on rough track. The machine shown is one of the industrial railway specialties built by the Orenstein-Arthur Koppel Co., of Koppel, Penn.

The 6½-ton engine for 24-in. gage has 6x11-in. cylinders and four 22-in. wheels on a 4-ft. wheelbase. In several respects the design of the engine follows European practice, notably in the use of plate frames and copper firebox and staybolts. This use of copper reduces the liability of burning or cracking of the firebox in rough handling. The boiler pressure is relatively high, 176 lb. The throttle valve is placed outside of the dome, with an outside steam pipe, and the exhaust pipes lead into the sides instead of the bottom



CONTRACTOR'S LOCOMOTIVE WITH TANK BETWEEN FRAMES

of the smokebox. The valve gear is also on the outside, so that there is ample room for the 130-gal. tank between the frames. The coal bunkers, forward of the cab, have a capacity of 540 lb. The tractive power is 2700 lb. A slightly larger engine, for the same gage of track, weighs about 7½ tons and has 6¾x11-in. cylinders. It has the same wheels and wheelbase as the other, but carries more fuel and water, and has a tractive power of 3400 lb. Both engines can traverse curves of 30-ft. radius.

* * *

Independent Electric Hoist Drive

An independent electric-motor outfit has been put on the market by the Mead-Morrison Manufacturing Co., of East Boston, Mass., for hoisting where it is desirable to substitute electric power for steam without discarding old equipment. A base plate carries the motor and two bearing pedestals which support a jackshaft geared to the motor. On one end of this shaft is mounted an automatic band brake, and on the other is a flexible coupling to be connected to the hoist crankshaft. A drum-type controller is mounted on the old hoist frame; instead of the ordinary handle a geared vertical hand-lever is used, working like the old engine throttle.

To connect a steam hoist to one of these outfits, the drive and eccentric rods are taken off the engine, the motor jackshaft and the engine crank-shaft are aligned, and the flexible coupling is fastened to the crank disk.

* * *

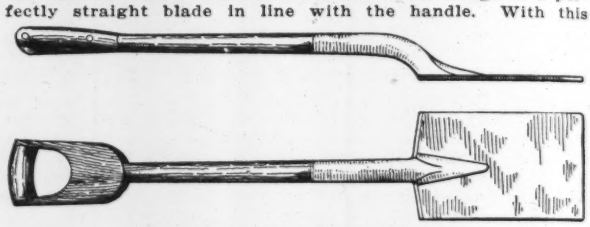
Recording Conveyor Scale

An integrating and recording weighing machine for conveyor systems has been devised by the Richardson Scale Co., of Passaic, N. J., and given the trade name of "Weightometer." There are a pair of weighing levers and a beam similar to those of platform scales, but arranged so that the weighing levers carry a short free section of the conveyor line. The beam also has no ordinary sliding weights but instead an iron cylinder suspended from near the long end and partly immersed in a mercury bath. Change of load on the levers is compensated for by the rise or fall of the float giving a movement of the beam proportional to the load. A totalizer on the beam end is worked by a pulley on the conveyor, so that it combines the number of loads and theoir weights. For cases where it is desired to tare the empty carrier, an automatic counterbalancing attachment is provided. A magnetic counter also duplicates the scale reading at any distant point.

* * *

Spade For Concrete Work

A special shape of spade for working concrete in the forms is shown by the accompanying sketch. It is intended for crowding the aggregate back and allowing the grout to flow against the face of the form, thus giving a dense surface to the finished work. The novel feature of its design is a perfectly straight blade in line with the handle. With this



SPECIAL CONCRETE SPADE

shape there is no liability of clogging by reason of concrete sticking to the spade, and the work is done more easily and effectively than with ordinary spades. The blade is 8x12-in.

This tool was designed by A. H. Bannister, general superintendent of the Brownell Improvement Co. (contractors), of Chicago, after several years' experience with concrete on track elevation and other large construction work. The right to manufacture it has been given to the Conneaut (Ohio) Shovel Co. and it is to be known as the Bannister special concrete spade.

* * *

New Railway Air-Brake System

An attachment to railway air-brake triple-valves, which is claimed to prevent the valve from causing quick action in a service application of the brakes, has been invented by J. R. Schneider and is being manufactured by the Pittsburgh Air Brake Co., 309 Classon St., Pittsburgh. This "no-kicker attachment," as it is called, is applicable to any standard triple valve. According to a paper read by Mr. Schneider before the Air Brake Association on May 6, this attachment, besides eliminating undesired quick action, enables the emergency action to be obtained at any time before or after service application and prevents the emergency action from "dying out" on very long trains.

Besides this device, the company manufactures a car-control valve and an engineer's brake valve. This latter can be used either with present standard automatic air brakes or with electro-pneumatic brakes.

* * *

Non-Corrosive Iron Alloy

An iron alloy resistant to oxidation or corrosion but capable of being machined is being made by the Bethlehem Foundry & Machine Co., South Bethlehem, Penn. The nature of the alloy is not disclosed. The metal for it is supplied by the Lennox Foundry Co., of London, England. Percentage losses of small specimens for 72-hr. immersion in various reagents have been found as follows: 98-per cent. sulphuric acid, 0.02; 1.4 nitric acid, 0.00; 25-per cent. tartaric acid, 0.03; 60-per cent. acetic acid, 0.00; saturated solution sodium hypochlorite, 0.01; 30-per cent. zinc chloride, 0.00; saturated ammonium chloride, 0.01; fused ammonium nitrate, 0.00.